Hastings International and Comparative Law Review

Volume 6
Number 1 *Fall 1982*

Article 2

1-1-1982

In Anticipation of Subterrestrial Delimitation

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I. INTRODUCTION

This Article explores an area scarcely touched upon in jurisprudence. The area is the most extensive on earth, namely, the earth itself, the millions of cubic miles below the surface of our planet.

It appears feasible at the present juncture of science and law to develop a theory of subterrestrial delimitation—a rationale through which jurisdictional limits can be drawn within the bowels of our earth. In order to create a meaningful theory of delimitation, certain facts must first be appreciated. The physical nature of the earth's interior must be portrayed. Instincts which support primeval and historical claims over territory need recognition. Additionally, the delimitation theories evolved by modern law for application to the oceans and the atmosphere warrant examination. These oceanic and atmospheric delimitation theories reveal some common denominators which can be integrated into a theory of subterrestrial delimitation.

II. THE INNER EARTH AS OWNED TERRITORY

Some of the strongest animal instincts concern land territory.[1] Ab-

* The author gratefully acknowledges the research assistance of Gary A. Ensor.

1. One author has hypothesized that man shares with animals an *inborn* urge to defend territory. The basis of this fierce instinct towards territoriality is thought to be genetic. *See generally* R. ARDREY, THE TERRITORIAL IMPERATIVE (1966). Other authors, while conceding that many animals do demonstrate territoriality, note that not all are so inclined. The orangutan is an example of a primate relative of man that does not claim territory, and certain human tribes, such as the Congo Pygmies, the Yahgan of Tierra del Fuego, and the Western Shoshone Indians, have no history of territorial warfare. 2 V. BARNOUW, AN INTRODUCTION TO ANTHROPOLOGY: ETHNOLOGY 213 (1971). It has been pointed out that man's territoriality may be the result of his carnivorous diet which led him to a cooperative hunting lifestyle. Such a lifestyle necessitated a fixed base—a common territory to be defended. *See generally* D. MORRIS, THE NAKED APE (1967).

sent any awareness of law, many animals instinctively delimit territory.[2] Wolves,[3] beavers,[4] and chimpanzees[5] by their nature demonstrate territorial claims. Primitive man laid claim first as a hunter and later as a cultivator to land instinctively claimed and guarded as jealously as an anatomical extension.[6]

Although there existed no access to the sky or to the earth's inner depths, the dominion instinct of man, as a highly evolved mammal, grasped for both.[7] As man's feelings of territorial claim ripened into

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2. Primates and other arboreal species mark the limits of their territory by micturition at strategic spots. J.E. PFEIFFER, THE EMERGENCE OF MAN 3.4 (1969).

3. The dwelling areas of wolves are marked off olfactorially and acoustically. Violation of the marked territory by an outsider will result in the wolves attempting to force the trespasser to areas beyond the instinctively claimed jurisdiction. E. ZIRMEN, THE WOLF: A SPECIES IN DANGER 232 (1981). The fact that wolves identify their territorial claims is certain; however, the exact means of delineation of territory are not completely understood. L.E. BUELER, WILD DOGS OF THE WORLD 43 (1973).

4. The most obvious areas in the beaver's domain are his dam and lake, limits created by the beaver's own efforts. One author has written:

> The depositing of castoreum obviously plays an important part in pairing, while at the same time has significance in the marking of territory. Strange beavers are not repelled by the markings of the owners of the territory . . . . When the members of a family know their own and each other's markings, they feel quite simply at home, and are stimulated to defend their territory against strange beavers.

L. WILSSON, MY BEAVER COLONY 131-32 (1968).

5. Chimpanzees *can* be aggressively territorial, more so than was previously realized. The males will patrol their home range, moving along the boundaries; occasionally (and silently) climbing trees to stare intently into a neighboring [sic] group's domain—they will sit vigilantly peering in one direction like this for up to ninety minutes. Occasionally, there are hostile encounters . . . .

A.J. DESMOND, THE APES REFLEXION 223 (1979).

6. Men who live a way of life in which they are primarily dependent on domesticated plants and animals for food are more bound to limited areas than are elemental men or advanced hunters and gatherers. The latter *feel a sense of ownership* of the wild plants and animals on their territory, but their degree of control over these plants and animals is small. Domesticators, who have direct control over domesticated plants and animals, *have an explicit notion of property* . . . And since it is necessary for the growth of their domesticates that sufficient land be available, the *notion of territory* that belongs to the group is refined: *the land becomes property that is more consciously and explicitly owned*, either privately or communally, than is the territory of elemental men or of advanced hunters and gatherers.

S. STRUEVER, PREHISTORIC AGRICULTURE 4-5 (1971) (emphasis added).

7. The grasp for territorial control appears to be directly related to the decline of certain animal senses in man. The migration of the eyes from the side of the head to an up-front position, while improving detection of what is close at hand, deprived man of the ability to detect movement across a wide portion of the landscape. As the ability to detect intruders diminished, the need to control the landscape itself increased. The ability to assert control over territory compensated for diminished surveillance ability.

The olfactory nerve in man, which carries signals from nose to brain, decreased in size. This evolutionary loss continues today. Man's olfactory nerve cells begin dying off prior to birth, and, by middle age, half of the remaining nerves are no longer functioning. As man

statements of law, the inaccessible territory was instinctively included within the ownership of immediately accessible land.[8]

A. A Foundational Theory of Dominion Under Land

Early legal concepts of ownership of surface property left dominion over the adjacent air and subsoil unrestricted. *Cujus est solum, ejus est usque ad coelum et ad inferos*[9] was the Roman law doctrine, trans-

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lost his acute senses of smell and sight, and as he gained size and lost agility, his territory expanded. The ratio of territory to agility appears to be inversely related. This phenomena is also witnessed in primal behavior. The most agile of monkeys maintain the least territorial control. Apes move through their territory of up to 20 square miles, while the faster, more agile, and lighter gibbons range within the low end on the monkey scale in territory, a fraction of a square mile. J.E. PFEIFFER, *supra* note 2, at 30-35.

The tendency of man's ancestors to occupy larger territories, not only in the forests, but in habitats outside the forests, may have been induced by weather changes (commonly referred to as loss of habitat)—dwindling vegetation in an environment becoming increasingly drier—which accompanied a greater sense of community, of grouping of individuals into "culture." The defense of the broadened territory has been identified as being the motivation behind aggressiveness in many animals, including modern man. The instinct of holding areas for the group's benefit accompanied by aggressively excluding others from the area appears to be a constant, expanding instinct which equates territorial control with survival. Although there is some evidence of certain African apes not engaging in the vigorous defense of territory, that modern human history is fraught with territorial conquest argues against humanity being a reflection of Rousseau's "gentle savage." G.L. ISAAC & E.R. MCCOWN, HUMAN ORIGINS: LOUIS LEAKEY AND THE EAST AFRICAN EVIDENCE 20-21 (1976).

8. The Chinese, as well as the Europeans and others, have recognized that the impressiveness of claimed territory is related to its size. The Chinese built cross-country walls far outside their city walls for protection, but also to delineate extended dominion. *See* C.F. HOCKETT, MAN'S PLACE IN NATURE 586 (1973). Dominion *under* and over surface territory appears to be a logical extension, bolstered by instinctive desire, to announce control over as large, and hence as impressive, an area as possible. The rationale that states have sovereignty over the bed and subsoil of their territorial sea is settled law. For a summary of historic theories of subsoil sovereignty under territorial seas, see Marston, *The Evolution of the Concept of Sovereignty Over the Bed and Subsoil of the Territorial Sea*, 48 BRIT Y.B. INT'L L. 321 (1976-77).

Marston recognized that under Roman law, subsoil was automatically included in the land mass whenever the coast and coastal waters were under the sovereign's control. The view that subsoil can be an extension of surface landmass underlies the Truman Proclamation on the Continental Shelf by which the President of the United States announced U.S. sovereignty over the continental shelf seabed and subsoil. The International Court of Justice (ICJ) has embraced a similar rationale of landmass extension in the North Sea Continental Shelf Cases, 1969 I.C.J. 3 (Judgment of Feb. 20, 1969); digested and exerpted at 63 AM. J. INT'L L. 591 (1969), *reprinted in* 8 INT'L LEGAL MATERIALS 340 (1969) [hereinafter cited as North Sea Cases].

These modern exercises in attaching sovereignty to subsoil all appear to have their roots deeply imbedded in the axiomatic or instinctive belief that control of the surface creates rights of sovereignty to the adjacent and subjacent subsurface.

9. Roby, writing of the classical Roman law in the time of Cicero and the Antonines (three to six centuries prior to the Justinian Institutes and Digest), said of ownership ('*dominium*') that it was the full right of doing whatever one liked

lated as: Whose is the land, his is also that which is above and below it.[10]

In recent centuries, man's mobility and increased community has complicated the primal desire for total dominion above and below territory. The seas and waterways are of necessity shared, and the skies above territories have, within limits, been relinquished. Although the jurisdictional limits between outer space and atmospheric sky are not absolutely settled, international law clearly recognizes delimitation of both.[11] Recent decades have also seen the most intense effort in history to define limits of jurisdiction over the seas and seabeds.[12] Only the

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with a thing and that in substance the owner of land had the full and free use of all above *and below* his land . . . freedom from interference with the air above *and the ground below*.

Cooper, *Roman Law and the Maxim* Cujus Est Solum *in International Air Law*, 1 McGILL L. J. 23, 26-27 (1952) (citing 1 H.J. ROBY, ROMAN PRIVATE LAW IN THE TIMES OF CICERO AND OF THE ANTONINES 414, 498 (1902)) (emphasis added).

10. As stated in R.S. VASAN, LATIN WORDS AND PHRASES FOR LAWYERS 56 (1980), "[t]he [o]wner of land owns everything above it (to the sky) and also everything beneath it (to the depths)."

It should be noted that Roman law was not only addressing state rights. Private rights derived from the state's dominion and sovereignty were being addressed. For an in-depth consideration of Roman law in this area, see W.W. BUCKLAND, THE MAIN INSTITUTIONS OF ROMAN PRIVATE LAW (1931).

The Roman rules were absorbed as common law and find expression in modern decisions in the United States. *See* Toth v. Bigelow, 1 N.J. 399, 406, 64 A.2d 62, 65 (1949), in which Justice Burling noted, "we are of the opinion that the possession of the surface carries with it the presumptive possession of the minerals beneath." The Court of Appeals of Ohio has stated: "(Whose is the land, his is also that which is above and below it). This maxim has been applied through the ages to a variety of circumstances, and many courts in this country and England, . . . have given it the sanctity of an axiom or corollary in the field of mathematics." *See* Antonik v. Chamberlain, 81 Ohio App. 465, 472, 78 N.E.2d 752, 757 (Ct. App. 1947).

11. *See infra* note 59 and accompanying text (reviewing some 30 different theories of space delimitation).

12. The international law of the sea is being fundamentally reconsidered at the ongoing Third United Nations Conference on the Law of the Sea (UNCLOS III). Due to the rapid evolution of international law in this area, one needs to distinguish between the law as it is (*lex lata*) and legal proposals (*lex ferenda*). *Lex lata* is embodied in the 1958 Geneva Conventions. *See* Convention on the Territorial Sea and the Contiguous Zone, Apr. 29, 1958, 15 U.S.T. 1606, T.I.A.S. No. 5639, 516 U.N.T.S. 205; Convention on the Continental Shelf, April 29, 1958, 15 U.S.T. 471, T.I.A.S. No. 5578, 499 U.N.T.S. 311; Convention on the High Seas, Apr. 29, 1958, 13 U.S.T. 2312, T.I.A.S. No. 5200, 450 U.N.T.S. 82. Any reader unfamiliar with the expansive changes in law of the sea being suggested at UNCLOS III is directed to Jennings, *A Changing International Law of the Sea* (1972B), 31 CAMBRIDGE L.J. 32 (1972); Ganz, *The United Nations and the Law of the Sea*, 26 INT'L & COMP. L.Q. 1 (1977); Knight, *Issues Before the Third United Nations Conference on the Law of the Sea*, 34 LA. L. REV. 155 (1974). For a sample of current concerns, see Reisman, *Key International Legal Issues With Regard to Ocean Thermal Energy Conversion Systems*, 2 CAL. W. INT'L L.J. 425 (1981).

millions of cubic miles beneath the crustal surface have escaped the slice of the juridical scalpel.

This Article seeks to answer the question, "To what extent is the inner earth owned and to whom does it belong?" The absence of any previous attempt to posit this question is not without reason. The inner earth is nature's darkest secret. Since Galileo turned his eyeglass to the heavens, man has gained direct perception of celestial phenomena at

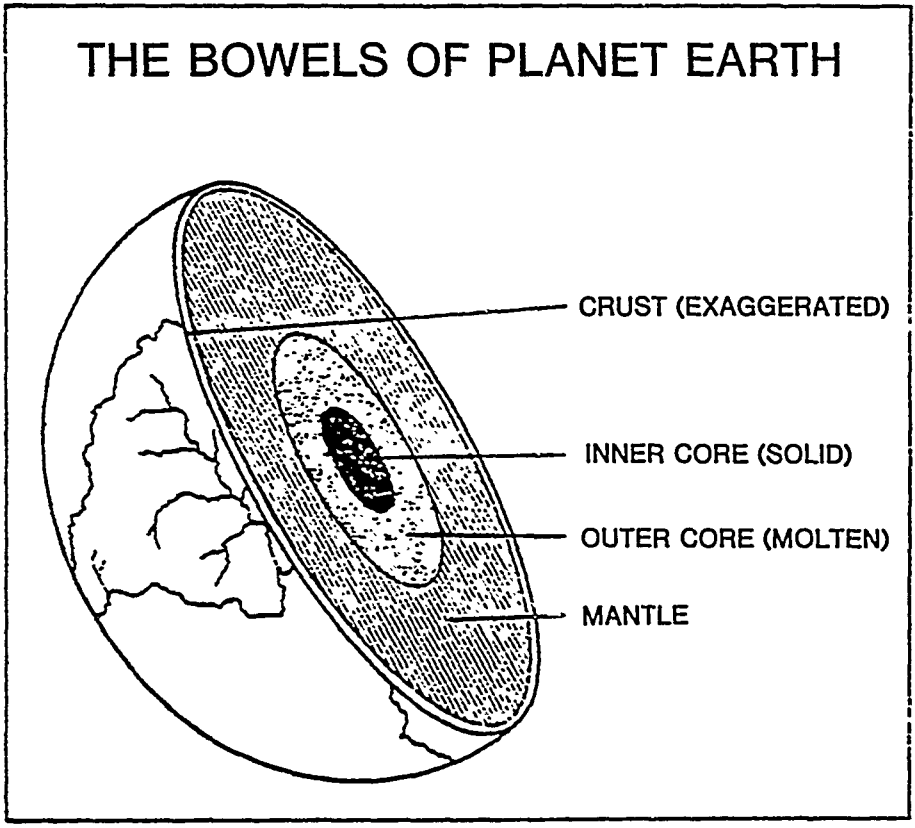

DIAGRAM I

Depiction composed from M. OZIMA, THE EARTH: ITS BIRTH AND GROWTH 72-33 (1981); J. ELDER, THE BOWELS OF THE EARTH 17 (1976); F. PRESS & R. SIEVER, EARTH 12-14 (2d ed. 1974).

incredible distances.[13] Modern knowledge of the globe's surface territory is nearly total because of direct observation and satellites with electronically assisted optics.[14]

Other than occasional volcanic belches from the subsurface, however, the inner earth remains a mystery. Only through the clamor of its existence, the echoes of seismic strain, can the scientist learn of the earth's inner nature.[15] As the depths increase, seismic waves, whether provided by nature or created by man, become more convoluted, skip, or cease altogether, providing a source of information from which to extrapolate the nature of the interior's substance and activities.

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13. The planet Earth sits near the far edge of the Milky Way galaxy, and until 40 years ago some astronomers still thought that the Milky Way was unique, that our galaxy was the universe. Today we know that there are worlds without end beyond it, galaxies with stars, dust and maybe even planets like our own. By fixing telescopes on these 'island universes,' astronomers hope to learn what is in store for the Milky Way.

Begley, *Worlds Past the Milky Way*, NEWSWEEK 66 (Mar. 15, 1982). These observations slight Galileo's proclamation, "As I stinted neither pains nor pence I was so successful that I obtained an excellent instrument which enabled me to see objects a thousand times as large and only one thirtieth of the distance in comparison with their appearance to the naked eye (Galileo Galilei)." E. DEBONO, EUREKA: AN ILLUSTRATED HISTORY OF INVENTIONS FROM THE WHEEL TO THE COMPUTER 194 (1974).

14. Unlike astronomical telescopes, which are in private hands, the terrestrial telescopes peering at the earth from satellites are in governmental control and are primarily instruments of surveillance. However, the public is made aware of some of the abilities of satellite optics through occasionally released photographs detailing the earth's surface.

15. An excellent discussion of seismology is presented in F. PRESS & R. SIEVER, EARTH 405-434 (1974) [hereinafter cited as EARTH].

> The seismograph is to the Earth scientist what the telescope is to the astronomer—a tool for peering into inaccessible regions. The ideal seismograph would be a 'skyhook,' a device fixed to a frame outside of the earth, so that when the ground shakes, the seismic vibrations could be measured by the changing distances between the fixed device and the ground. Because this is impossible to achieve, a compromise is struck by loosely coupling a mass to the Earth so that the ground can vibrate without causing appreciable motion of the mass. The mass is coupled to the Earth by means of a pendulum . . . or by suspending it from a spring . . . When the ground moves, the mass tends to remain stationary because of its inertia, and the displacement of the Earth relative to the stationary mass is used to sense the ground movement.

Id. at 405-07.

The most advanced instruments are capable of measuring from New York to California seismic reactions equivalent to just 1 mm. *Id.* at 408.

Geophysicists distinguish between "P waves," those which are created from shock within the earth similar to dominoes compressing one into the other, and "S waves," those which undulate similar to waves set up by throwing a rock into a pond. S waves travel at a slower rate than P waves and are unable to penetrate deep into the core, whereas P waves travel throughout the inner earth. For a full discussion, see H. TAKEUCHI, S. UYEDA, H. KANAMORI, DEBATE ABOUT THE EARTH 34-39 (1967) [hereinafter cited as DEBATE].

B. Geophysical Influences Affecting Dominion over Land

Although ancient man's naiveté under the Roman law is understandable in the light of his ignorance of the true physical nature of the earth and cosmos, that doctrine is strained in the face of current geophysics. Direct ownership to the earth's center naively presumes the earth to be circular, solid, divisible, and pie-like. Earth scientists now know better.[16] The earth is miles wider at the equator than at the poles. It undulates; the surface areas shift on tectonic plates and continents split, plunge to the depths, and recirculate.[17] The core of the earth, although solid, is within a molten sea which is itself encased within yet another solid core, shifting, cracking, and churning above it.[18]

Many experts believe the earth is growing and becoming hotter;[19]

16. Geophysicists estimate that the polar radius of the earth is some 21 km less than the equatorial radius. This difference is thought to be caused by the bulging of the earth due to its girth being accelerated outward as the earth spins on its axis. The "centrifugal force" affects matter more at the equator than at the poles, throwing it outward, creating what geophysicists call "oblateness." This oblateness renders the earth a flattened fluid sphere—an oblate spheroid, a distortion (from perfect spherical shape) which can be calculated with considerable accuracy. *See* O. PHILLIPS, THE HEART OF THE EARTH 55-60 (1968).

17. Heat flow by conduction is a phenomenon well known to anyone who has held a metal object in a flame. Heat from the inner earth is, by a very slow process of conduction, transferred through rock to the surface. It is now generally agreed in geophysics that the major heat transfer from inside the earth to the surface occurs by "convection." Convection occurs when heated material itself moves, as when water boils or when hot air moves upwards in a chimney. Heated currents of rock actually flow, forming ascending and descending plumes and countercurrents. For a specific diagram of the convection process, as theorized by D.H. Turcotte and E.R. Oxburg, see EARTH, *supra* note 15, at 338. Pieces of the surface territory will descend inside the earth during the convection process and eventually melt. An incisive discussion, with considerable mathematical explanation, can be found in A. COX, PLATE TECTONICS AND GEOMAGNETIC REVERSALS 452-62. *See also* W. GLEN, CONTINENTAL DRIFT AND PLATE TECTONICS, chs. 3, 5, 7 (1975). The significance to the lay person is that continents, now apart, were once together. Surface territories were once substance in the subsurface. The earth is, in a sense, alive with unceasing motion which belies our common-sense feeling of a solid, stable, unchanging globe. Although it is beyond the scope of the present Article, it is interesting to note that geophysical change points to the eventual destruction of all surface territory through movement and circulation. This idea raises havoc with normal notions of ownership of specific areas of surface land.

18. One of the most difficult notions for the layperson to grasp is that the apparently solid inner core of the earth is surrounded by an outer, molten core. This rather recent discovery is generally agreed to be the state of the deepest resources of the inner earth. *See* O. PHILLIPS, *supra* note 16, at 123, figure 44. *See also* J. ELDER, THE BOWELS OF THE EARTH 17 (1976). For an explanation of the formation of the core, accompanied by diagrams depicting the inner solid core and the liquid outer core, see EARTH, *supra* note 15, at 428, figure 17-37. Although the inner core is hotter than the outer core, it is speculated to be solid due to much greater pressure at earth's center. The pressures, temperatures, and compositions of the cores are not known with total certainty. Most authorities believe that both cores are iron. *See* O. PHILLIPS, *supra* note 16, at 120-25.

19. The traditional view of the earth held it to be in a state of slow cooling, shrinking

all know it is undergoing cataclysmic change. Scientists have made audio recordings of more than 60,000 earthquakes during a decade. Played back, the recorded quakes deliver a symphony simulating wind rushing through a forest, with intermittent periods of silence and finales of seismic booms. This melody is stark evidence of the manic nature of the inner earth.[20]

Fueled by ongoing fission and fusion, the earth's radioactive innards, molten and solid, contain oceans of caloric and other energies which campaign for greater understanding. Though as inaccessible today as the airspace of yesterday, the earth's innards possess substance and energy which transcend ordinary comprehension.[21] When man will directly contain and use these mammoth reserves is unknown. Theoretical bases for ownership of them, however, can presently be hypothesized, and, in light of modern knowledge regarding the nature of the subsurface, development of such a theory of delimitation is long overdue.[22]

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from a former, larger, and much hotter state. Since Becquerel discovered radioactivity, however, it has been appreciated that the inner earth is also heated by radioactivity, heat generated by the decay of radioactive minerals. *See* DEBATE, *supra* note 15, at 75-82. Radium, for instance, releases heat at a constant rate of 140 calories per gram per hour. *Id.* at 80.

20. An in-depth, verbal, and graphic description of seismology including interesting anecdotes related to music and high fidelity electronics is found in EARTH, *supra* note 15, at 407, 425.

21. The heat of the inner earth is not merely contained like heat within a thermos. It is self-generating. Even granite contains small quantities of radioactive uranium and thorium. Approximately one hundred-thousandth of a calorie of heat is generated per gram per year in granite. This phenomenon seems insignificant only if one overlooks two facts. First, the heat generated in the earth is trapped, and only slowly dissipates through convection and conduction through the rock-mass, which is a poor conductor of heat. Second, the passage of not just one year, but millions of years, superheats the interior. One might question why the earth has not totally melted during the eons. In fact, it has, many times over. It is only the loss of heat at the surface which keeps the continents, oceans, and seabeds from melting, and in the case of the seas, vaporizing. The two phenomena to keep in mind here are the "bedquilt" effect of the outer earth, which traps the heat being generated inside the earth, and the cooled surface, which, with its cool skin of outer exposure, constantly remains solid (with the rare exception of volcanic eruption). For a cogent discussion of all of the above phenomena, see M. OZIMA, THE EARTH: ITS BIRTH AND GROWTH 1-10, table 1 (1979). For the amounts of uranium, thorium and potassium contained in rocks, and for the heat generated by radioactive isotopes per year per gram, see *id.* at 7, table 2.

22. Reexamination of historic statements can remind us of how much we err when we fail to anticipate technological improvements. "A lawyer must only be concerned with things which may have a practical importance. In so far as human activity is no longer possible in the air, *we have no reason to raise or answer the question of jurisdiction at all.*" ZITELMANN, LUFTSCHIFFARTSRECHT NIEMEYERS ZEITSCHRIFT 23 (1910), *reprinted in* G. GAL, SPACE LAW 62 (1969) (emphasis added).

III. THE GEOPHYSICAL PROFILE OF SUBTERRESTRIAL TERRITORY

A. A Functional Model of Inner Earth

With an immediate apology to geophysicists, it is necessary amid their intricate scientific findings to develop a simple, yet functional, model of the inner earth. Some model must be established, or legal discussion of subterrestrial delimitation is obviated. At the outset, it is acknowledged that the depiction set forth here reflects the plausible, and not the absolutely certain, attributes of our planet. Modest mention of the evidence sustaining the model's existence will be disclosed to render more credible the nearly incredible (from the layperson's standpoint) inner earth.

Starting at the center of the earth, and radiating approximately 750 miles outward, is a solid inner core primarily consisting of iron.[23] Surrounding the inner core is an outer core, a molten sea 1400 miles deep, again composed substantially of iron.[24] The inner core sustains temperatures up to 5200 degrees Fahrenheit.[25] The inner core's solid state, despite this high temperature, is accounted for by its increased density under immense gravitational pressure.[26] The existence of both cores is deduced from the known behavior of different types of seismic waves passing or failing to pass through the cores following earthquakes.[27] Above the outer core is the mantle, which extends more than eighteen hundred miles outward to the earth's crust.[28] The crust is a thin granitic layer from three to approximately thirty-five miles in thickness.[29]

Neither the earth's surface nor its innards are stationary. Powered by energy from radioactivity and the residual heat from early planetary existence, a tectonic engine circulates the matter through the eons.[30]

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23. *See* O. PHILLIPS, *supra* note 16, at 120-25.

24. *See also* W. GLEN, *supra* note 17, at 10.

25. *Id.* at 15.

26. "In all likelihood, the inner core is hotter than the outer core but is solid because the higher pressure at the greater depths counteracts the effect of the higher temperature and prevents the inner core from melting." *Id.* at 16.

27. *See supra* note 15.

28. *See supra* text accompanying note 24.

29. It should be noted that "crust" is not intended to mean only the continents and islands above water. The "crust" is a thin "skin" over the entire globe upon which the oceans float and of which the continents are constituted. *See* W. GLEN, *supra* note 17, at 9-10.

30. *See supra* note 17.

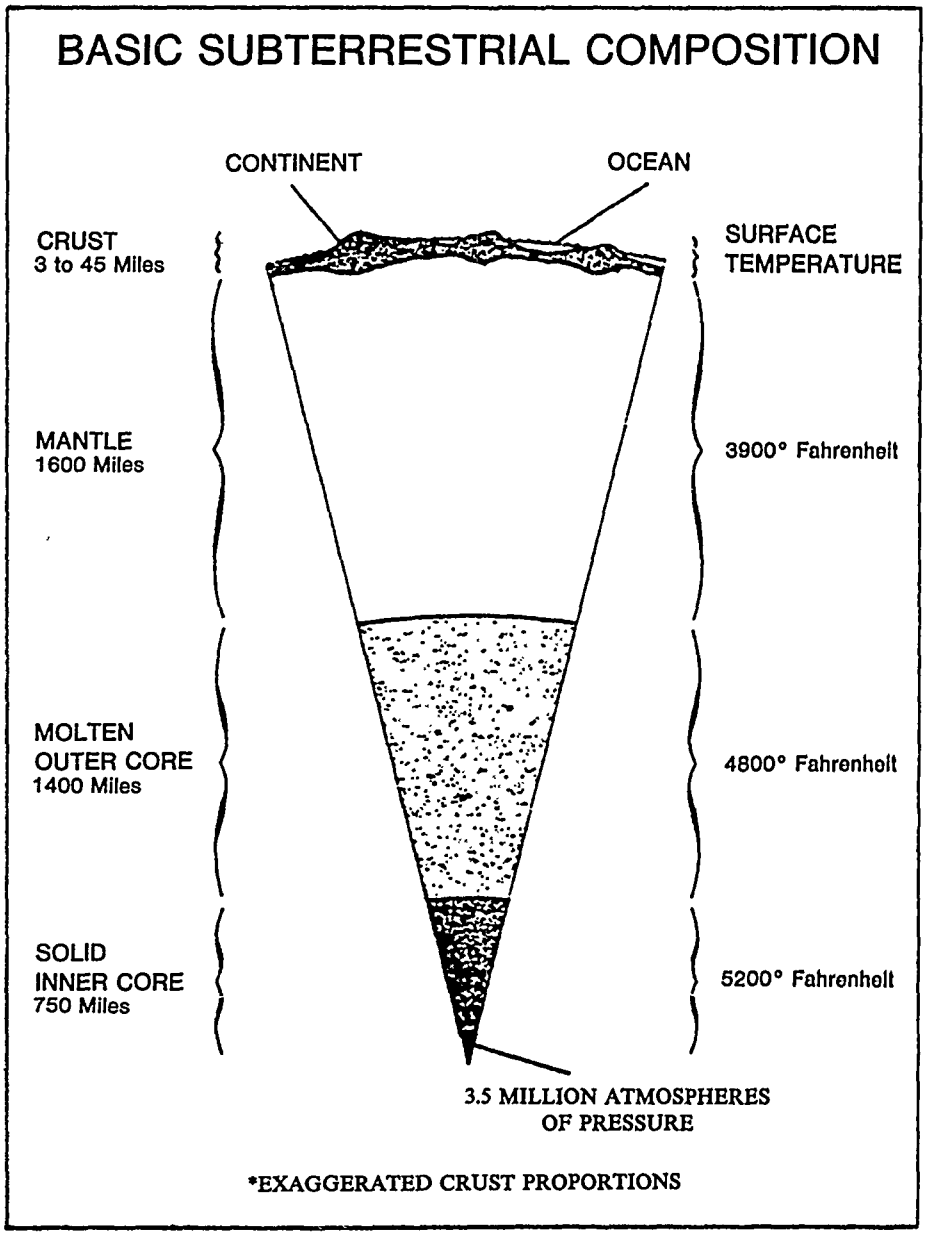

DIAGRAM II

Depiction composed from H. TAKEUCHI, S. UYEDA, H. KANAMORI, DEBATE ABOUT THE EARTH 38 (1967); W. GLEN, CONTINENTAL DRIFT AND PLATE TECTONICS 8-17 (1976); O.M. PHILLIPS, THE HEART OF THE EARTH 61-83 (1968).

Roughly analogous to cooking soup, warming countercurrents and descending plumes churn to depths of hundreds of miles in the subsurface.[31] The resultant wandering of continents and the shifting of polar regions are items of keen debate in current science. What needs to be appreciated for delimitation purposes, however, is the fact that the earth's surface and interior are undergoing immense, unceasing change.[32] There is no room for a naive presumption that the earth is a single, solid, static mass.

B. Value and Technology

From a practical standpoint, it can be observed that the law is not operative within the void created by the valueless. So long as the inner earth is viewed as inaccessible, its riches, in whatever form, are unlikely to excite legal concern. These resources will become more meaningful and justiciable when they are obtainable and usable.[33] A blatant example of the transition which occurs when inaccessible resources become accessible is the present controversy over mining and ownership of manganese nodules on the deep seabed.[34] Legal expressions rested as quietly as the nodules prior to their appropriation.[35] Once the appropriation was a reality, immense legal effort was incited.

The potential value of the inner earth resides in three subterrestrial resources: energy, space, and minerals. The realization of this value presupposes an escalation in technology.

1. Inner-Earth Space[36]

Regions many times larger than the existing oceans and continents

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31. *Id.*

32. For a description of the dramatic changes which have taken place during the past 200 million years, and an attempt to recreate Pangaea, an ancient single landmass from which all present continents derive, see EARTH, *supra* note 15, at 457-82.

33. For a discussion of the interrelationship of economics and the extractive industries, see C. PARK, EARTHBOUND 25-46 (1975).

34. *See* Arrow, *The Proposed Regime for the Unilateral Exploitation of Deep Seabed Mineral Resources by the United States*, 21 HARV. INT'L L.J. 337 (1980).

35. *Id.* at 341-44.

36. *See* C. PARK, *supra* note 33, at 257.

> If one could foretell the future status of conservation of the environment, one would know the future of the human race. What we have to conserve is not one but *all of our requirements of space, energy, and minerals*. The environment we must protect is the *entire earth* . . . . The awesome aspect of the situation is its magnitude the interrelationship of its components, and the fact that it demands from man almost immediate action, objectivity, knowledge, wisdom, and cooperation. The hopeful aspect is that man has shown forethought about his

are present inside the earth. The mantle, the 1800-mile-deep area between the earth's crust and the molten inner core, is the greatest spatial resource.[37] Future ability to displace sufficient space within the earth for practical use augments the value of inner earth regions.[38] As the value of space becomes clear, the need for justiciable limits in these realms will be heightened.

The creation of livable or otherwise usable space within the earth is beyond current technology. It is equally apparent that the enormous escalation of technology which has occurred in the twentieth century, when expanded further by future developments, can reasonably be imagined as providing the means necessary to capitalize on the resources of the inner earth. The difference between current ability in space creation and that of the future is equivalent to the technological evolution of dynamite and atomic explosives as compared with the power of the pick and shovel. Space-creation technology, though yet unrealized, is not beyond realization in the future — it can be anticipated. The anticipation whets the urgency for legal definition of and limits upon subterrestrial space.

2. Inner-Earth Energy

Modern civilization is preoccupied with the earth's crustal wealth in fossil-based energy.[39] Oil and coal reserves fuel present economies, and their uneven distribution[40] and foreseeable exhaustibility intensify the concern. The millions of cubic miles of superheated inner earth,

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future and is already trying to do something about the conservation of his environment.

Id. (emphasis added).

37. *See supra* Diagram II.

38. The extreme temperatures within the mantle, up to 3,900 degrees Fahrenheit, and the present, apparent impossibility of using space in the molten core, should not blind one to potential future use. For instance, it might be possible to create vacancies via atomic means and cool the walls of the caverns with ocean water. The space could be used for storage of atomic waste, or, if mastery of cooling systems were sufficient, liveable subterrestrial territory might be a reality in the distant future. The hypothetical of living within the earth is not more remote than was man's walking on the moon in centuries past. *See supra* Diagram II.

39. The fossil fuels of the world have been calculated in terms of quantity related to kilowatt-hours of energy. Coal and lignite are by far the greatest, almost 20 times as abundant as the next most plentiful fossil fuel, petroleum liquids. Natural gas, tar-sand oil, and shale oil, in descending order, form small fractions compared to the coal reserves. *See* EARTH, *supra* note 15, at 563. *See also supra* Diagram II.

40. The known percentages of oil reserves of the world are: Middle East 53%, Africa 16%, Russia and Communist Block 15%, U.S.A. 5%, Indonesia 2%, Canada 2%, Venezuela 2%, Europe 2%. *See* C. PARK, *supra* note 33, at 135.

though presently inaccessible, are potentially more productive and valuable as an energy source than crustal fossil fuel sources.

Geothermal energy has been successfully tapped in the earth's crust.[41] To date, however, geothermal energy has only been captured along volcanic and earthquake belts which are neither generously nor equally distributed over the globe.[42] Yet, where captured, geothermal energy is providing power rivaling the largest hydroelectric generators in dams.[43] If technological advancement were to provide direct tapping of the geothermal heat sources present under all land masses, oceans of such energy, rather than mere streams, would become a reality. Great technological advances would be essential to tap and transport this energy, whether in the form of steam or, possibly, in the form of electricity created at the heat source.

Crustal sources of radioactive substances are presently being mined, and energy produced by fission[44] and eventually by fusion[45] is realizable. Projection downward into the inner earth may find radioactivity to be a substantial source of the heat which renders the earth's core molten.[46] Operation of the earth's spinning core as an electrogenerator,[47] capturing the energy of the earth's rotation through its own

41. Italy, New Zealand, Iceland, California, Japan, and Mexico have engaged in energy production from geothermal sources. *Id.* at 174.

42. *Id.* at 175. The fact that geothermal energy has, to date, been tapped only along the earthquake belts should not preclude future geothermal energy taps any place on the globe, providing improved technology is able to tap the superheated mantle beneath the earth's crust. *See supra* Diagram II.

43. Deep wells have been driven in the Geysers region of California, where the 1974 capacity was reported in excess of 400,000 kilowatts. The Pacific Gas and Electric Company, which uses the power generated by the steam, intends to add 563,000 kilowatts of geothermal power. The combined systems would have a capacity equivalent to that of Hoover Dam on the Colorado River. *See* C. PARK, *supra* note 33, at 175.

44. Fission is the radioactive decay of atomic nuclei, accompanied by the creation of heat. Rapid conversion of uranium 235 into more stable compounds results in an atomic bomb. The controlled, slow, and continuous conversion is the nuclear process which provides usable energy in nuclear reactors. *Id.* at 175-76.

45. Fusion is a potential production of nuclear energy quite different from fission. Fusion of certain isotopes found in "heavy water" is the basis of the thermonuclear bomb. Energy created by fusion has not yet been containable due to the extremely high temperatures (millions of degrees) which would melt any known fission-type reactor. It is hoped that plasma physics, the containment of the thermonuclear reaction in an electromagnetic field, may make fusion a useful source of energy production. *Id.* at 179.

46. Most radioactivity is thought to occur near the surface, yet there may be some at great depths in the earth's core. For a discussion of the ongoing debate regarding distribution of radioactive heat generation within the earth, see O. PHILLIPS, *supra* note 16, at 138-51.

47. The earth's magnetic field is thought to have originated in a self-exciting dynamo, one similar to a simple generator involving a copper disk turning through the magnetic field

electrical field, is also a potential source of energy.

Assuming such extreme advancements in technology, sources of accessible energy more abundant than crustal fossil resources reside within the earth. The legal boundaries upon these energy sources are presently unknown.

3. Inner-Earth Minerals

The existence of the earth's minerals is certain, and the type, quantity, and location of these minerals has been systematically deduced.[48] Present scientific inquiry indicates that iron, molten and solid, is the primary substance in the core.[49] Quantities are so great and surface availability remains so expansive, however, that only moderate interest in deep inner-earth extraction of iron is excited.

The practical concern with minerals in this Article is that they form the millions of cubic miles of substance holding energy and space. The massive oceans of minerals, molten and solid, are the subterranean territory across and through which inner-earth delimitation will be mapped.

IV. IS THERE SUBTERRESTRIAL LAW?

There presently exists no treaty or other legal device which limits the depth of subterrestrial ownership among nations. It might be assumed that the maxim *cujus est solum, ejus est usque ad coelum et ad inferos*[50] is, or at least provides, an inculcated concept designating subterrestrial jurisdiction.[51] The maxim requires major qualification. It

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of a bar magnet or, in the magnet's place, a coil which, so long as the system turns, "self-excites." *See* Elsasser, *The Earth as a Dynamo*, 1958 SCI. AM., May 1958, at 44-48. For a discussion of the mystery of the earth's magnetism and the difficulties of explaining the earth's ability to generate electricity, see DEBATE, *supra* note 15, at 94-132.

48. The major metals in the earth's crust are iron, aluminum, magnesium, titanium, chromium, and manganese. Minor metals in terms of abundance in the crust are copper, lead, zinc, nickel, silver, mercury, platinum, and gold. Nonmetals located in the crust are salt, phosphate rock, sulfur, potassium, diamond, gypsum, limestone, clay, and asbestos. *See* EARTH, *supra* note 15, at 5848-85, table 22-5. A discussion of the earth's minerals, their locations, abundance, atomic numbers, economic significance, uses, and retrieval is found *id.* at 574-93.

49. *See* O. PHILLIPS, *supra* note 16, at 120-25.

50. *See supra* notes 9 & 10. This common-law doctrine [hereinafter cited as *ad coelum et ad inferos*] translates as "[t]o whomsoever the soil belongs, he owns also to the sky and to the depths. The owner of a piece of land owns everything above and below it to an indefinite extent." BLACK'S LAW DICTIONARY 341 (5th ed. 1979).

51. Modern perspectives on the extent of spatial jurisdiction developed from early interpretations of the origin of dominion. G. SCHWARZENBERGER & E. BROWN, A MANUAL OF INTERNATIONAL LAW 74 (6th ed. 1976). These early theories indicate a principle that makes

needs to be recognized that the Romans and other early western cultures had no conception of the earth as a round object.[52] The most enlightened men of antiquity surmised mythically, not scientifically, that the goddess Urania held the stars in her hand and attached them to the sky above.[53] The earth below, far from being encapsulated in a sphere, was thought to be subterranean land under an ostensibly flat surface.

A. The Influence of Science upon the Development of Law

As science rejected the perception of the earth as flat, the law failed to respond. The universal rule has steadfastly remained that subsoil is appurtenant to land of the surface owner.[54] The widespread

possession of the earth a "gift from the Creator," 2 S. PUFENDORF, DE JURE NATURAE ET GENTIUM LIBRI OCTO 536-37 (Oldfather trans. of 1688) (1964), and is "associated with the proprietorship of a limited position of the earth's surface." H. MAINE, ANCIENT LAW 204 (3d ed. 1888). Maine, citing Blackstone, states that "the earth and all things therein were the general property of mankind from the immediate gift of the Creator." *Id.* at 148 (1917). The early case of Hannabalson v. Sessions, 116 Iowa 457, 461, 90 N.W. 93, 95 (1902), was the first to state, "[i]t is one of the oldest rules of property known to the law that the title of the owner of the soil extends, not *only downward to the center of the earth*, but upward usque ad coelum . . ." (emphasis added).

Without speculating as to the extent of change, however, Loth and Ernst intimate that "[this] pronouncement about property rights underground has been eroded a little bit." D. LOTH & M.L. ERNST, HOW HIGH IS UP: MODERN LAW FOR MODERN MAN 31 (1964).

52. Cooper, *Roman Law and the Maxim* Cujus Est Solum *in International Air Law*, 1 MCGILL L.J. 23 (1952). It is stated that "Roman law did not hesitate to provide the same degree of state control in areas above the surface as it did on the surface itself wherever and whenever deemed advisable or necessary." *Id.* at 26.

53. G. GAL, *supra* note 22, at 69.

54. Hannabalson v. Sessions, 116 Iowa 457, 461 (1902). *See supra* note 51 and accompanying text. *Accord*, Shell Oil Co. v. Manley Oil Corp., 37 F. Supp. 289, 292 (E.D. Ill. 1941); Provo City Corp. v. Knudsen, 558 P.2d 1332, 1334 (Utah 1977) (stating "in addition to the right of peaceable possession of his property the owner has quite a number of other rights and privileges which he should be able to exercise without limitation or restraint, including in the air above and the earth beneath"); Shell Oil Co. v. Stansbury, 401 S.W.2d 623, 632 (Tex. Civ. App. 1966) (stating "[a]n acre is a measure of land measured on the surface of the land but including the earth beneath to the center of the earth"); Stueve v. City of Cincinnati, 168 N.E.2d 574, 577 (Ohio Ct. App. 1960) (stating "an abutting property owner is 'vested with the fee of the land extending from the center of the earth, upward between the lines of his lot produced to the center of the street' "); Pyramid Coal Corp. v. Pratt, 229 Ind. 648, 652, 99 N.E.2d 427, 429 (1951) (stating "[i]t is a fundamental maxim that the title to land extends down to the center of the earth and up to the heavens, within the lines of gravitation"); Toth v. Bigelow, 1 N.J. 399, 404, 64 A.2d 62, 64 (N.J. 1949) (stating "[a]t the common law the rule was that ownership of the surface imported ownership of an indefinite extent, upwards and downwards. The term land was noman [sic] generalissimum including not only the face of the earth but everything under it. Cujus est solum, ejus est usque ad inferos. . . . This rebuttable presumption of the common law is the rule in other jurisdictions as well as our own"); Ingold v. Phoenix Assur. Co., 230 N.C. 142*, 52 S.E.2d

approval resulted more from the absence of any statement of law to the contrary than from the existence of reasoned law in support of the rule.

It would surprise the Romans of yesterday to find that the national empires of today are geographically closest to each other by traveling in straight lines through the earth rather than by surface routes over the earth.[55] Furthermore, in the strictest sense of the Roman maxim,[56] nations opposite each other on the surface of the globe are, at the same instant, under each other's surface territory. The absurd result under the maxim is that globally opposite states are under and, therefore, within each other's territory.

In modification of this absurd, unlimited extension of the subsurface boundary, a cone theory exists.[57] The cone theory evolved as a means by which to determine limits of jurisdiction above territory.[58] By implication, however, it assists subterrestrial delimitation by recog-

366, 368 (1949) (stating "[t]he ownership of land is not confined to its surface, but extends indefinitely downwards and upwards"); Amphitheaters, Inc. v. Portland Meadows, 184 Or. 336, 334, 198 P.2d 847, 850 (Or. 1948) (stating "[o]wnership of lands . . . includes . . . not only the face of the earth, but everything under it or over it, and has in its legal signification an indefinite extent upward and downward, giving rise to the maxim, Cujus est solum ejus est usque ad coelum"); Jones v. Vermont Asbestos Corp., 108 Vt. 79, 105, 182 A. 291, 303 (1936) (stating "the possessor of the surface of the soil, will be deemed to be in possession of whatever lies underneath the surface, since land includes, not only the ground or soil, but everything attached to it above or below"); Edwards v. Sims, 232 Ky. 791, 793, 24 S.W.2d 619, 620 (1930) (stating "the owner of realty, unless there has been a division of the estate, is entitled to the free and unfettered control of his own land above, upon, *and beneath* the surface. So whatever is in a direct line *between the surface of the land and the center of the earth belongs to the owner of the surface*") (emphasis added); Langhorne et al. v. Turman, 141 Ky. 809, 815, 133 S.W. 1008, 1011 (1911) (stating "[T]he plaintiff was in the lawful possession and use of his own property. The land was his, and, as against the defendant, by an absolute right from the centre usque ad coelum. The defendants could not directly infringe that right by any means or for any purpose").

"Today, the view prevails that a frontier of a state is not represented by a line but by a plane which vertically delimits the land and air space of a state, including the subsoil." M. SORENSEN, MANUAL OF PUBLIC INTERNATIONAL LAW 320 (1968). "The rule universally accepted is that the subsoil belongs to the state which has sovereignty over the surface." I. BROWNLIE, PRINCIPLES OF PUBLIC INTERNATIONAL LAW 121 (3d ed. 1979).

55. It logically follows that the shortest distance between two opposite points on a sphere is a straight line through the sphere rather than around the surface.

56. *See supra* notes 9 & 10.

57. United States v. Causby, 328 U.S. 256, 260-61 (1946), declares, "[i]t is ancient doctrine that at common law ownership of the land extended to the periphery of the universe—*Cujus est solum ejus est usque ad coelum*. But that doctrine has no place in the modern world." Also, it has been stated that "[t]his theory is generally considered very weak . . . . We shall not elaborate on absurd implications of the infinite limit, such as the propagation of the vertical extensions of national borders." Perek, *Scientific Criteria for the Delimitation of Outer Space*, 5 J. SPACE L. 111, 120 (1977).

58. J.L. BRIERLY, THE LAW OF NATIONS: AN INTRODUCTION TO THE INTERNATIONAL LAW OF PEACE 219 (6th ed. 1963). The author states:

nizing that subsurface territory is logically linked to, and necessarily terminated at, the earth's center.[59] Under this theory, a cone projects from the center of the earth, through national surface boundaries and out into space infinitely. The cone's infinite spaceward extension from the finite earth center presents severe problems regarding the earth's rotation and the resultant implications for modern physics.[60] The practical result has been an accommodation created by the recognition of the cone projection up to, but not including, the point where the earth's atmosphere ends and space begins.[61]

> A state's territorial air space has hitherto been assumed to be the whole cone of air space extending indefinitely upwards from the surface of its territory and territorial sea. Recent developments in rocket-propulsion, however, have called in question the adequacy of this concept of territorial air space, and have underlined the need for a more precise definition of its upward extent.

Id.

59. As a reminder of man's physical limits, a vertical delimitation into outer space is inextricably linked to the earth's surface. In Perek, *supra* note 57, at 115, it is expressed that "the determination of a relative position of an object [should be made in regards] to the limiting surface."

60. For example, Jenks, *International Law and Activities in Space*, 5 INT'L & COMP. L. Q. 99, 102 (1956) points out that:

> . . . any projection of territorial sovereignty into space beyond the atmosphere would be inconsistent with the basic astronomical facts. The revolution of the Earth on its own axis, its rotation around the sun, and the motions of the sun and the planets through the galaxy all require that the relationship of particular sovereignties on the surface of the earth to space beyond the atmosphere is never constant for the slightest conceivable fraction of time. Such a projection into space of sovereignties based on particular areas of the earth's surface would give us a series of adjacent irregularly shaped cones with a constantly changing content. Celestial bodies would continually move in and out of these cones all the time. In these circumstances, the concept of a space cone of sovereignty is a meaningless and dangerous abstraction.

For a good reflection on the concept of infinite sovereignty and the conal theory, see G. GAL, *supra* note 22, at 67.

61. *See* W. HYMAN, MAGNA CARTA OF SPACE 196 (1966), wherein it is stated: "[t]he important thing is to establish some line of demarcation between airspace and outer-space. . . . The [airspace is] under the complete and exclusive sovereignty of the subjacent nation [while] outer-space shall be free from the claim of sovereignty of any individual nation." It must be noted, moreover, that characterizing a demarcation between airspace and outer-space involves the study of various types of definitions, technological and legal. The term atmosphere refers to the region that exists between the earth's surface and orbital space. Orbital space refers to that region in which objects will circle the earth at least once if given the proper velocity. The more familiar but less precise term is outer-space. Sloup, *The NASA Space Shuttle and other Aerospace Vehicles: A Primer for Lawyers on Legal Characterization*, 8 CAL. W. INT'L L.J. 403, 406-07 (1978). Though the Treaty on the Moon and Other Celestial Bodies of 1967, art. 2, in force Oct. 10, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 "is now comparatively old," D. ORR & M. SOROOS, THE GLOBAL PREDICAMENT: ECOLOGICAL PERSPECTIVES ON WORLD ORDER 220 (1979), it establishes the broad principle that "[o]uter space, including the moon and other celestial bodies, is not

Although a law of mid-earth delimitation has not been proposed by any nation, it can be strongly inferred that the principle historically accepted is the concept comprehended by the Roman law.[62] The only modification was the wedge shape of subsurface ownership necessarily imposed by recognizing that the earth is round instead of flat.

B. Terminating the *Coelum et ad Inferos* Rationale

A strong argument can be made today that international law should abandon the concept of sovereignty *et ad inferos*. The argument which repudiates the Roman maxim stems from analogous treatment in international law of national sovereignty over other extended territories, such as the seas and the atmosphere.[63]

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subject to national appropriation by claim of sovereignty." The changing technology regarding flight and space travel, therefore, "[has] a significance in any consideration of a legal division between airspace and outer-space." S. LAY & H. TAUBENFELD, THE LAW RELATING TO ACTIVITIES OF MAN IN SPACE 16 (1970).

62. *See supra* notes 10 & 50.

63. S. LAY & H. TAUBENFELD, *supra* note 61, at 56-57, reveals that:

> [I]t is inevitable that states and lawyers will borrow directly and by way of analogy from developments in other areas which appear to the decisionmaker to be relevant. . . . In general, then, the analytical rather than a direct 'legal precedent' use of historical analogies is called for. It can well contribute to a predictive theory (or analysis) of what will be.

With regard to sovereignty over extended areas in the seas, it has been recognized in Newton, *Inexhaustibility as a Law of the Sea Determinant*, 16 TEX. INT'L L.J. 369, 407 (1981) that

> there are no easy demarcation points in history; rather, there is a continuity which clearly emerges only in retrospect because minority views can be downplayed or ignored. It is the lack of consensus which makes general review appropriate, for in disputes over the norms for ownership, control and use of the oceans lie the seeds of explanation of ongoing changes in the law of the sea. . . . Traditional law of the sea makes the following provisions for control of ocean use. *The territorial sea is subject to the ownership, control and use of the coastal state.*

(Emphasis added.) With regards to sovereignty over extended areas in the atmosphere it has been recognized in S. LAY & H. TAUBENFELD, *supra* note 61, at 39, that

> it is by now clear that every national state claims and, to the extent it can do so, exercises complete sovereignty in superjacent airspace. [A]ir space remains legally undefined for most purposes with no generally accepted limit to its extent.
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> . . . .
>
> Granting that nations are sovereign in superjacent air space, a vast number of scholars have . . . proposed limiting the extent of this iron control by limiting the definition of airspace itself.

Id. at 43. According to D. LOTH & M.L. ERNST, *supra* note 51, at 23, "[p]erhaps we can draw inspiration for a practical legal course from the law of the sea. The oceans are international beyond a fixed territorial boundary—you can argue about whether it is three miles out or more—so it is said that there must be a territorial limit in the (ground) too."

The oft-cited Cannon Shot Rule,[64] whereby a nation claimed sovereignty over adjacent sea to the extent of its firepower, is an historic assertion of extraterritorial jurisdiction. Under the rule, sovereignty was asserted beyond the landmass, yet disclaimed beyond the cannon's reach. Although technology has advanced to the point where no stretch of ocean is beyond a modern nation's firepower,[65] nations have

64. C. VAN BYNKERSHOEK, DE DOMINIO MARIS DISSEPTATIO 41, 44 (Carnegie Classics of International Law 2d ed. 1923) states:

> The possession of a maritime belt ought to be regarded as extending just as far as it can be held in subjection to the mainland . . . . Hence we do not concede ownership of a maritime belt any farther out than it can be ruled from the land, and yet we do concede it that far; for there can be no reason for saying that the sea which is under some man's command and control is any less than ditch in his territory.
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> . . .
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> . . . .
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> *Wherefore on the whole it seems a better rule that the control of the land (over the sea) extends as far as cannon will carry; for that is as far as we seem to have both command and possession.*

(Emphasis added.) This view seems to be a development from the early progeny prior to the Greek civilization. For example, Newton, *supra* note 63, at 373, states that

> early inhabitants of the Levant, the eastern Mediterranean, endeavored to control the seas in their immediate area. Their concept of control or dominion over the seas was apparently a literal extension of their concept of control over land. Examinations of statements made about this exercise of control makes it clear that military power and political prowess were at the heart of 'control.'

E. DE VATTEL, LAW OF NATIONS OR THE PRINCIPLES OF NATURAL LAW 108-09 (Carnegie Classics of International Law 1916) states that

> the most reasonable rule that can be laid down is that in general the sovereignty of a State over its marginal waters extends as far as is necessary for its safety and as far as it can be effectively maintained. . . . *Today the area of marginal seas which is within reach of a cannon shot from the coast is regarded as part of the national territory* . . . .

(Emphasis added).

65. Newton, *supra* note 63, at 403-04, introduces the question, "If domination from land is the way to establish ownership, what happens when the range of cannon increases?" Considering the rapidly progressing sophistication of contemporary armaments, including the maneuverability of advanced weapons systems, the distance of "effective control" increases immeasurably. For example, examine the latest technology in ordinary avionics. It is believed that

> [t]he most formidable force for detecting, tracking and intercepting hostile air threats is the AWG-9/Phoenix [Missile] System [carried by the F-14 Tomcat]. Beyond the range of enemy fighter radar, the F-14 can track and evaluate up to twenty-four targets at one time. From a stand-off position, it can launch its six Phoenix missiles simultaneously against the greatest threats and still monitor eighteen additional targets.
>
> The missiles—with their supersonic speed, 25-g turn capability, terminal radar homing guidance and ECM resistance—allow one F-14 to defeat a half-dozen [enemy targets at] distances of over 100 miles, and from sea level to over 100,000 feet. [This provides] the greatest air defense capability in existence.

continued to limit their claims over adjacent "territorial seas."[66] The fact that some nations honor a three-mile limit,[67] while others claim several hundred miles, does not alter recognition of the certainty that a nation's claim to adjacent seas is limited.[68] No nation claims unlimited sovereignty in the ocean, and international jurists have universally treated the high seas as *res communes*[69] or *res nullius*.[70]

Development of the concept of delimited space about the earth is of recent vintage[71] and is a striking development abrogating the *coelum*

Grumman Aerospace Corp., *The F-14/Phoenix Team*, U.S. NAVAL INSTITUTE PROCEEDINGS 65 (Aug. 1981).

66. In a recent address by U.S. Ambassador George N. Aldrich, Acting Special Representative of the President for the Law of the Sea Conference, before the National Association of Manufacturers on December 9, 1980, *reprinted in* SEABED RESOURCES: LAW OF THE SEA Policy No. 255 U.S. DEP'T OF STATE, Bureau of Public Affairs 2 (Dec. 9, 1980) [hereinafter cited as LAW OF THE SEA], it is revealed that at the Third Conference on the Law of the Sea (UNCLOS III), it was proposed that "coastal states agree to navigational protections and the limitation of territorial seas to 12 miles in breadth in return for the recognition by all other states of 200-mile economic zones."

67. In Cunard Steamship Co. v. Mellon, 262 U.S. 100, 122 (1923), the Court comments that

> [i]t now is settled in the United States and recognized elsewhere that the territory subject to its jurisdiction includes the land areas under its dominion and control, the ports, harbors, bays and other enclosed arms of the sea along its coast and a marginal belt of the sea extending from the coast line outward a marine league, or three geographic miles.

68. "High seas are that part of the sea not falling under the sovereignty of any state. They extend beyond the limits of the territorial sea and stretch over vast spaces, linking continents and serving the interests of all states." M. SORENSEN, *supra* note 54, at 346.

69. "*Res communes*. In the civil law, things common to all, that is, those things which are used and enjoyed by everyone, even in single parts, but can never be exclusively acquired as a whole. . . ." BLACK'S LAW DICTIONARY 1173 (5th ed. 1979).

70. "*Res nullius*. The property of nobody. A thing which has no owner, either because a former owner has finally abandoned it, or because it has never been appropriated by any person, or because (in the Roman law) it is not susceptible of private ownership." *Id.* at 1174.

Regarding the modern appreciation and application of the *res nullius* and *res communis* doctrines, see M. SORENSEN, *supra* note 54, at 346, wherein it states, *inter alia*, that

> [t]he application of the principle of the freedom of the seas was linked to the question whether or not it was appropriate or possible to establish sovereignty over the high seas. Two main theories were formulated in reply to this question. The first was that the high seas were *res nullius*; the second that the high seas were *res communis omnium*. The latter theory prevails today and it adopts as its basis the idea that the high seas should be subject to the common use by all states.

71. M. ARSANJANI, INTERNATIONAL REGULATION OF INTERNAL RESOURCES: A STUDY OF LAW AND POLICY 100 (1981) observes, "[i]n the early twentieth century, with the expansion of commercial flights, legal regulations began to emerge."

As recently as 1910, the United States Civil Code descriptively announced that "the right of the owner of the lands extends downward and upward indefinitely." D. LOTH & M.L. ERNST, *supra* note 51, at 1. It was not until 1919 at the Paris Convention on Aerial Navigation (reaffirmed in 1944 at the Chicago Convention on International Civil Aviation)

et ad inferos maxim. When the Russian space satellite, Sputnik, first orbited the earth,[72] there was an outcry in the United States demanding Sputnik be shot down as a trespasser. Since Sputnik, more than thirty different theories have been offered regarding delimitation of the atmosphere and space.[73] Again, it is not so much the disparity in theory or practice which is of the moment. Rather, it is the fact that jurisdiction in airspace[74] and outer space[75] is universally recognized as being limited.[76]

As previously noted, the Roman maxim's rationale is the only stated principle to date pertaining to subterrestrial jurisdiction. International law has, however, by pervasive custom and convention, denied the sovereign jurisdiction extensions into space and the high seas suggested by *coelum et ad inferos*.[77] Analogous reasoning indicates that subterrestrial jurisdiction should be contained within limits below the surface. The delimitation, it will be argued, must be accomplished well in advance of the earth's center.

An example of the gross effect of unconditional application of the Roman maxim is noteworthy. A small nation, such as Liechtenstein,

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that particular demarcation implications were considered. Moreover, as recently as 1977 at the International Telecommunications Union/Broadcasting Satellite Conference in Geneva, it was declared that a satisfactory definition dealing with demarcation had yet to be propounded. *See* Perek, *supra* note 57, at 111. "Today your absolute sovereignty over the air above your house is gone. Just how much is left is a matter for legal jousting rather than legal exactitude." D. LOTH & M.L. ERNST, *supra* note 51, at 1.

72. Sputnik I was launched in 1957. S. LAY & H. TAUBENFELD, *supra* note 61, at 14.

73. Lay, *Recent Developments in Space Law*, 9 CAL. W. INT'L L.J. 514 (1979). See S. LAY & H. TAUBENFELD, *supra* note 61, at 43, for a diagrammed summary of some of the major theories in space delimitation.

74. "*Airspace*: . . . the space lying above the earth or above a certain area of land or water; *esp.* the space lying above a nation and coming under its jurisdiction." WEBSTER'S SEVENTH NEW COLLEGIATE DICTIONARY 20 (1969).

75. "*Outer Space*: . . . space immediately outside the earth's atmosphere." *Id.* at 599. *See also* Sloup, *supra* note 61.

76. RESTATEMENT (SECOND) OF FOREIGN RELATIONS LAW OF THE UNITED STATES § 16 reporter's note (1962) [hereinafter cited as RESTATEMENT (SECOND) OF FOREIGN RELATIONS LAW], regarding current theories of space limits, states that

> [o]n December 20, 1961, the United Nations General Assembly unanimously adopted a resolution commending to states for their guidance in the exploration and use of outer space the principle that 'outer space and celestial bodies are free for exploration and use by all States in conformity with international law and are not subject to national appropriation.' . . . *In this action there is a recognition that the jurisdiction of a state does not extend indefinitely outward from the earth's surface without a limit or limits of some kind.*

(Emphasis added.)

77. According to W. HYMAN, *supra* note 61, at 192:

> At present time, however, there is no international agreement on [the question con-

or, to a greater extreme, an archipelagic area such as the Galapagos, could claim sovereignty to the subsoil in excessive disproportion to the national surface territory. The small nation or archipelagic areas could, under this maxim, claim tens of thousands of cubic miles of subterranean earth. Although it can be urged that such small nations or archipelagic areas may rightfully lay substantial claims to the atmosphere under present law, the depth and the solid character of the earth's subsurface resources make a subterranean claim disproportionally greater. A claim embracing *all* subterrestrial earth between the surface and the earth's center is likewise disproportionate when compared to the claims of states to territorial seas. Even the largest nations make claims of sovereignty over their territorial seas which are only small fractions of their surface land area.[78] The potential claims to subterrestrial mass by large nations would be high multiples, not frac-

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cerning the proper delimitation of outer space] since there is no accord as to the point at which air space ends and outer-space begins.

At present scientists agree that there are 5 layers which constitute the atmosphere around the earth. They are:

a. The troposphere, which is zero to 10 kilometers above the earth's surface (6 miles);

b. The stratosphere, which is 10 to 40 kilometers above the earth's surface (6 to 25 miles);

c. The mesosphere, which is 40 to 80 kilometers above the earth's surface (25 to 50 miles);

d. The thermosphere, which is 80 to 375 kilometers above the earth's surface (50 to 235 miles);

e. The exosphere, which is 375 kilometers above the earth's surface (235 miles and beyond).

The mesosphere, thermosphere and part of the exosphere together combine into what is generally referred to by scientists as the ionosphere (definitions vary). The exact outer limits of the ionosphere have not as yet been definitely determined. Scientists have placed this limit between 310 and 620 miles above the earth's surface. Beyond the ionosphere lies . . . outer space. [These] terms . . . have not been utilized in the formulation of national statutes and international agreements, and thus, there appears to have been no scientific approach to control of air travel prior to this generation.

See also RESTATEMENT (SECOND) OF FOREIGN RELATIONS LAW, *supra* note 76. According to S. LAY & H. TAUBENFELD, *supra* note 61, at 42:

[T]he official view of the United States and that of the Soviet Union, as far as it can be determined, are [sic] similar on most points. *Both agree that national sovereignty ends at some point 'out,'* but each retains its right to counter deleterious acts, wherever they occur. Neither encourages the formal drawing of a line delimiting sovereign claims based on a territorial concept, but both agree that satellites fly in nonsovereign outer-space . . . .

(Emphasis added.)

78. By way of comparison, consider the size of territorial land mass of the United States and its claim to a disproportionately small territorial sea. *See* LAW OF THE SEA, *supra* note 66.

tions, of their surface area upon application of the *coelum et ad inferos* rationale.[79] The sheer dimension of inner-earth areas as compared to surface areas makes the rationale to limit subterrestrial claims at some reasonable depth below the surface persuasive. Moreover, the fact that outer space and the high seas are universally considered beyond national sovereignty[80] creates strong precedent for the argument that the bowels of the planet should likewise be characterized as beyond national sovereignty.

V. SITUATIONS WHICH INCITE CONCERN ABOUT SUBTERRESTRIAL JURISDICTION

When Drake first drilled for oil in Pennsylvania in 1859, there was no issue raised as to whether resources under the land were owned by the surface owner. Even the deepest wells capturing and exploring resources have not incited inquiry as to whether such activity extended *deeper* than national jurisdiction. The Roman maxim has been universally accepted, at least regarding the depth of modern probes into the earth's crust.[81]

The instant situation corresponds to what occurred with the onslaught of surface technology. The creation of the tallest buildings and towers did not prompt legal inquiry into whether such structures had exceeded the state's surface jurisdiction.[82] The use of conventional aircraft[83] likewise did not attract jurisdictional attack.[84] Radical techno-

79. *See supra* notes 9 & 10.

80. *See* D.J. HARRIS, CASES AND MATERIALS ON INTERNATIONAL LAW 213 (2d ed. 1979). *See also* M. SORENSEN, *supra* note 54, at 346.

81. G. GAL, *supra* note 22, at 52-53.

82. The earliest balloon flights, however, posed some conflict, at least initially. *Id.* at 53 states that "[a]t the initial stage of aviation the states did not know how to deal with the new set of facts created by balloons . . . ."

83. Conventional aircraft are, primarily, the most familiar flight vehicles and "constitute the largest number of flight vehicles. Until the widespread use of rocket propulsion following World War II, pure air vehicles relied on buoyancy (aerostats) or aerodynamic lift for support (aerodynes) . . . . The term aircraft is the broadest term used in relation to pure air vehicles." Sloup, *supra* note 61, at 408-09. S. LAY & H. TAUBENFELD, *supra* note 61, at 43 states:

> To proceed logically (if naively from the political point of view), it is possible to suggest a 'scientific' limitation in airspace as the height at which a human can live without artificial breathing apparatus, conceivably as high as ten miles. With perhaps more *operational* meaning, the maximum height to which aircraft can ascend has been offered as a definition, at least within the outlook of the civil aviation conventions, for airspace or 'atmospheric' space. This would place it, given present technology, at about twelve miles for conventional aircraft or perhaps twenty to twenty-five for the ram jet [sic].

(Emphasis added.)

logical developments, however, did raise the issue. Once nations sent moving and stationary satellites into orbit, issues of jurisdiction were vehemently argued.[85]

Advances in technology which will enable radical intrusions into the earth's interior will also incite immediate jurisdictional disputes. Consider the three following hypothetical intrusions into the subterrain. These situations should prompt legal concern for subterrestrial jurisdiction.

A. Subterrestrial Vehicles

It is not beyond the reach of future technology to devise earth-piercing vehicles,[86] robot or otherwise, which, in the fashion of armor-

84. S. LAY & H. TAUBENFELD, *supra* note 61, at 44, postulates that "[o]ne special problem of the use of the concept of aerodynamic lift and 'aircraft,' whether considered under the terms of the civil air-law conventions or not, is that, due to technological change, it no longer has an operationally clear justification." For an excellent synopsis of the classes of flight vehicles, see Sloup, *supra* note 61.

85. Perek, *supra* note 57, at 114, regarding satellites and the competence of science to propose a criterion for the definition of outer space, states that

> [i]n space, science is in a position to indicate, e.g., the region of lowest perigees of artificial satellites. This region is quite definite and the present state of knowledge and experience with satellites launched since 1957 is sufficient to pinpoint the region with an accuracy of about 10 km.
>
> . . . .
>
> [A]rtificial satellites of the earth move in outer space. Statistics of satellite orbits show that satellites launched into a variety of orbits in the last 18 years, serving many different practical purposes of research and application, invariably decayed above 100 km height.

Id. at 118. Additionally, Gorbiel, *The Legal Status of Geostationary Orbit: Some Remarks*, 6 J. SPACE L. 171-72 (1978) states, *inter alia*:

> Incessant progress of the space science and technology produces new possibilities for the use of outer space and as a result the need for new legal regulations has arisen. A significant example of this is the problem of the use of the so-called geostationary orbit. The geostationary orbit is a circular orbit located at a distance of about 35,800 kilometers over the earth's equator. A satellite placed in this orbit turns about the polar axis of the earth in the same direction and with the same period as that of the earth's rotation. . . . [W]ith the advent of claims to exclusive sovereignty by equatorial countries over segments of this orbit, it has become the focus of heated discussion.

86. As the German Wehrmacht learned early in World War II, a combination of pentaerythritol tetranitrate and trinitrotoluene can create sufficient heat to melt through the side of a tank. The chemical, later called "Pentolite," formed the warhead fired from the bazooka, a weapon used by the United States against tanks in World War II and the Korean conflict. *See* ENCYCLOPAEDIA BRITANNICA 315 (1968). A higher technology, based on nuclear fusion, could melt through subterrestrial rock in advance of a vehicle. The rock piercing needs of the vehicle would obviously be reversed at great depth, where the futuristic needs of the vehicle would be for cooling as it pierced the molten regions of the inner earth. The needed propellants and cooling mechanisms are not presently known technology, yet

piercing weaponry, would travel through solid substances. Such vehicles, although presuming the development of propellants, heat retardants, and guidance systems presently unknown, seem nonetheless within the stream of technological evolution. Once it is presumed that a nation could "launch" subterrestrial vehicles, which for scientific or reconnaissance purposes would travel at great depth below the surface, immediate jurisdictional concerns arise.[87]

If the United States were to launch such a vehicle to a depth of 4000 miles, would the vehicle still be within United States territory? If the vehicle were guided from the United States to subterrestrial regions under Mexico, would Mexico's national sovereignty be violated? If not violated at 4000 miles depth, would it be violated at a depth of 500, 100, 50, or 5 miles?[88] Or is all territory below a nation to the center of the earth as the *coelum et ad inferos* rationale dictates, sovereign soil of the superjacent state?

B. Subterrestrial Energy Syphon[89]

Assume that Japan, through advanced technology, were capable of tapping the molten portion of the core of the earth under its island borders. Assume further that enhanced technology enabled direct con-

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appreciation of the geometric progression of current technology would not seem to exclude their development in the distant future.

87. The subterrestrial jurisdictional issues would also be raised if tunneling became pronounced. Deep subterrestrial tunneling which joined nations, passed under other nations, looped, and returned to the same state would all activate serious jurisdictional concern. Intercontinental tunneling has been envisioned. *See* D. & M. WHITE, FAMOUS SUBWAYS AND TUNNELS OF THE WORLD 91-94 (1953). For an understanding of past technology in tunneling methods, see E. WAHLSTROM, TUNNELLING IN ROCK 203-22 (1973).

88. There is ripe opportunity for subterrestrial jurisdictional disputes, assuming that vehicles traveling in tunnels or otherwise would at some time collide. Would the collision site determine jurisdiction? Would one state have jurisdiction if one of the involved vehicles were to return to the surface state's jurisdiction? A variety of interpretations, depending on the facts, would be of concern as in the classic *Lotus* case, in which a high-seas collision between Turkish and French vessels occurred. *See* France v. Turkey, 1927 P.C.I.J., ser. A, No. 9.

89. The concept of an energy syphon is the result of extending known thermoelectric technology. In 1821, a German physicist, T. Seebeck, discovered electricity could be generated in wires of iron and copper when coupled together in the presence of extreme heat. The "thermocouple," or "thermopile" (where multiple couples are used), generates electricity in the presence of heat absent any moving parts. For a lay explanation, see A. BENDER, SCIENCE PROJECTS WITH ELECTRONICS AND COMPUTERS 111-18 (1977). An in-depth discussion of the "Seebeck effect" can be found in B. BLEANEY, ELECTRICITY AND MAGNETISM 103-109 (2d ed. 1965). Technologically advanced utilization of the concept would, in theory, enable conversion of the core's heat to electricity. The potential to create a mass conversion of the inner earth heat has inspired—for purposes of example—the energy syphon.

version of substantial portions of the inner earth's heat to electricity. If the heat taken from depths below Japan's territory were removed in such quantities as to cool the inner earth, would this energy reduction be a conversion of a resource belonging to nations other than Japan? Is the heat at such depth a resource in Japan's territory? Is the molten core of the earth *res communes*, common property of all mankind, or is it *res habiles*, subject to capture? At what point below the surface might superjacent sovereignty terminate?

C. International Slant Drilling[90]

Although drilling underground at a slant has been perfected to depths in excess of a mile, its future use at far greater depths via heightened technology is not precluded. If it were assumed that the slant drill were perfected to points hundreds of miles below the surface laterally under an adjacent state, immediate jurisdictional problems would arise. If West Germany were to slant drill for resources below East Germany, would the slant drilling be a trespass? Would extrusion of mineral resources be a theft? If a crime occurred, in what jurisdiction would the crime have taken place?

VI. ARE THE BOWELS OF OUR PLANET THE COMMON HERITAGE OF MANKIND?

Once it is urged that the sovereignty of nations terminates in subterrestrial areas at less depth than the earth's center, the question of characterizing the extrajurisdictional remainder is presented. The bowels of the earth could, by analogy, fall within Hugo Grotius' definition of the high seas, as free to all men—*mare liberum*.[91]

The major international convention addressing the high seas

90. Ability to sink wells at other than vertical angles and the technology enabling the angles to be changed drastically at different depths are accomplished arts. *See* H. Rollings, *World Oil Drilling Handbook* 72-90 (1969), *reprinted from* WORLD OIL. Drilling technology has been augmented by nuclear explosives. *See* F. KREITH & C. WRENN, THE NUCLEAR IMPACT 209-30 (1976).

91. The Grotian thesis was based on a belief in a natural order, the belief that freedom of the oceans was a state of fact, not a choice of man. This thesis was not an invention of Grotius alone. Researchers have traced his thinking to Francis Alphonso de Castro, a mid-16th century Spanish monk. The concept was also not foreign to Roman characterization of the sea as *commune omnium*. For a condensed, yet diverse source of the contributions of Hugo Grotius and others to the *mare liberum* concept, see G. SMITH II, RESTRICTING THE CONCEPT OF FREE SEAS: MODERN MARITIME LAW RE-EVALUATED 13-24 (1980). *Mare clausum seu de dominio maris*, a theory by which the King of England was the "proprietor" of the seas as an appendix of the British Empire, and the emergence of coastal state's right

merely termed them to be "all sea not . . . included in the territorial sea or internal waters of a state."[92] The remaining sea territory, termed high seas, was not designated in Grotian terms as "free to all men." It was, however, considered an area in which all nations exercised specific, shared freedoms of movement and use.[93]

The working draft of the United Nations Third Conference on the Law of the Sea (UNCLOS III) designated "the Area" in the seas beyond national jurisdiction as "the common heritage of mankind."[94] Of

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and other appurtenant developments in the history of sea law are abundantly documented in comprehensive source materials. *Id.* at 24-30.

In J. SELDEN, MARE CLAUSUM 142-43 (M. Nedham trans. 1652), it can be seen, by way of analogy to appropriation of ocean commodities, that the extrajurisdictional resources of Mother Earth were sought to be protected. Therein it is stated:

> It is obvious to every man, that the gain of such a Voyage . . . may be lessened, and that the abundance either of Pearls themselves, or of those shell-fishes, which produce them, may through a promiscuous and common use of the Sea, be diminished in any Sea whatsoever. Where then is that inexhaustible abundance of Commodities in the Sea, which cannot be impaired?

92. Geneva Convention on the High Seas of 1958, U.N. Doc. A/CONF. 62/WP. 8 Pt. V, art. 73 (1958).

93. *Id.* Art. 2, stating:

> The high seas being open to all nations, no State may validly purport to subject any part of them to its sovereignty. Freedom of the high seas is exercised under the conditions laid down by these articles and by the other rules of international law. It comprises, *inter alia*, both for coastal and non-coastal States:
> (1) Freedom of navigation;
> (2) Freedom of fishing;
> (3) Freedom to lay submarine cables and pipelines;
> (4) Freedom to fly over the high seas.

An example of a freedom not enumerated is the freedom to undertake research on the high seas. The omission is likely traceable to desire not to authorize nuclear experimentation. Similar omission or curtailment will likely effect future consideration of freedoms within the subterrestrial portion of our planet.

94. United Nations Third Conference on the Law of the Sea, A/CONF. 62/WP.10/Rev.3, Aug. 27 (1980) [hereinafter cited as UNCLOS III], states:

> *Article 136*
>
> Common heritage of mankind
>
> The Area *and its resources* are the *common heritage of mankind*.
>
> *Article 137*
>
> *Legal status of the Area and its resources*
>
> 1. No State shall claim or exercise sovereignty or sovereign rights over any part of the Area *or its resources*, nor shall any State or person, natural or juridical, appropriate any part thereof. No such claim or exercise of sovereignty or sovereign rights, nor such appropriation shall be recognized.
>
> 2. All rights in the resources of the Area *are vested in mankind as a whole, on whose behalf the Authority shall act*. These resources are not subject to alienation. The minerals derived from the Area, however, may only be alienated in accordance with this Part of the present Convention and the rules and regulations adopted thereunder.
>
> 3. No State or person, natural or juridical, shall claim, acquire or exercise

particular interest is the fact that the draft convention considers the "substances"[95] under the ocean to be common property among nations and suggests shared freedoms within the Area. The working draft of UNCLOS III has not yet been adopted. It nonetheless reflects active juridical thought which defines water and mineral territory beyond national jurisdiction in terms of common ownership. The same rationale of common interest can be applied by analogy to subterrestrial areas beneath the oceans and under continents.

Hugo Grotius also treated the air as "one of the things belonging to mankind in common."[96] More recent authors declared during the dawn of air flight, "*L'air est libre*."[97] Major nations, however, eroded this concept as technology provided them with access to higher and higher airspace.[98] These nations claimed sovereignty over the "entire airspace above their land . . . ,"[99] and then, in the face of technological advancement in rockets[100] and satellites,[101] realized that sovereignty

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rights with respect to the *minerals of the Area* except in accordance with the provisions of this Part of the present Convention. Otherwise, no such claim, acquisition or exercise of such rights shall be recognized.

(Emphasis added.)

95. *Id.* Art. 133, stating:

(a) Resources means mineral resources *in situ*. When recovered from the Area, such resources shall be for the purposes of this Part of the present Convention regarded as minerals.

(b) Resources shall include:

(i) Liquid or gaseous *substances at or beneath the surface* such as petroleum gas, condensate, helium, and also sulphur and salts recovered in liquid form;

(ii) Solid substances occurring on the surface or at depths of less than three metres below the surface, including polymetallic nodules;

(iii) *Solid substances at depths of more than three metres below the surface*;

(iv) Metal-bearing brine at or beneath the surface.

(Emphasis added.)

96. G. GAL, *supra* note 22, at 48. *See also* H. GROTIUS, FREEDOM OF THE SEAS 28 (R. Magoffin trans. 1916).

97. G. GAL, *supra* note 22, at 49.

98. W. HYMAN, *supra* note 61, at 191, declares that

[d]ealing with space boundaries is admittedly difficult. . . . It has been recommended that sovereignty in the skies be limited by means of an international arrangement based on types of spacecraft, probable functions and potential dangers. Such a theory might find difficulty, however, in the flux of a technological situation in which types, functions and dangers are subject to constant change.

99. *See* 49 U.S.C. 1508(a) (1976) regarding a declaration of national sovereignty in airspace.

100. *See* S. LAY & H. TAUBENFELD, *supra* note 61, at 13, stating, "The distinguishing feature of the rocket, in contrast to the more familiar vehicles that depend on principles of aerodynamic lift, is that it does not depend on the atmosphere. In a real sense, it works best in a vacuum and is hence ideally suited for outer space activities."

101. *Id.*

could not in practice extend indefinitely above a nation.[102]

Although it was not unanimously agreed at what point sovereignty in airspace terminated, it was recognized, as with the oceans, that sovereignty was limited.[103] Unique points of demarcation were suggested, such as the outer limit of the earth's gravitational pull,[104] the upper limit of the earth's atmosphere,[105] the highest limit of aerodynamic lift,[106] and the upper limit of sustainable human life.[107] These and other theories merely emphasize the acceptance of airspace as a limited phenomenon, terminating not more than hundreds of miles above the earth's surface.

Another significant recognition of limits upon sovereignty in space is the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.[108] Although dated, this treaty remains the most recent comprehensive expression of international law in this area.

The combined recognition of the airspace and oceanic sovereignty of nations as limited points to outer space and the high seas as areas beyond sovereign jurisdiction.[109] As shared resources, they are the common heritage of all mankind. The subterrestrial earth, larger by far than the oceans and more extensive than the earth's atmosphere, invites similar characterization.

VII. TO WHAT DEPTH SHOULD NATIONAL SOVEREIGNTY EXTEND?

Once it is determined that the bowels of the earth should be legally characterized as territory common to all nations, the question of delim-

102. RESTATEMENT (SECOND) OF FOREIGN RELATIONS LAW, *supra* note 76. *See also* S. LAY & H. TAUBENFELD, *supra* note 61, at 51, stating:

> At some point there is a limit or limits to the extension of terrestrial sovereignty and that in time practical international necessities will lead to a relinquishment of, at least, extreme claims. Whether it will turn out to be one line or several lines, or several zones, etc., will depend on the future of space technology and the fruits of space activities and exploration and on the nature of the space regime which evolves.

(Footnotes omitted.)

103. *See* S. LAY & H. TAUBENFELD, *supra* note 61, at 51.

104. G. GAL, *supra* note 22, at 71-73.

105. *Id.* at 73-79.

106. *Id.* at 79-84.

107. *Id.* at 84-85.

108. *Id.* at 97-98, stating "suggestions range from ten km. to over one million km." *See also id.* at 114-16.

109. D.J. HARRIS, *supra* note 80; M. SORENSEN, *supra* note 54.

itation arises. As will be seen, ascertaining the point at which a state's sovereignty below the surface ends and subterrestrial *res communis* begins[110] is elusive and, upon examination, entails problems at least as demanding as those presented by the atmosphere,[111] outer space, and the oceans.

A. Delimitation at a Set Depth Below Land Surface

Assume, *arguendo*, that a nation was granted exclusive jurisdiction to a depth of three miles below land surface. This limit would result, in certain instances, in subterrestrial *res communes* being above a nation's lowlands. For example, the Chilean coast would be below the inner earth portions of the Chilean Andes.[112] An even more dramatic example is that the portions of Mount Everest three or more miles below the pinnacle would be surrounded by the sovereign territory of Nepal, which would be situated well below the *res communis* within the Himalayas.[113]

It is doubtful that the world's nations would acquiesce in a rigid scheme of delimitation which, in certain circumstances, would preclude

110. *Res communis omnium*, or *res extra commercium* as it is sometimes called, A. SCHWARZENBERGER, INTERNATIONAL LAW 309 (3d ed. 1976), has been extensively used in describing the high seas. *See* Convention on the High Seas, art. 2, *supra* note 12, which states in part, "The high seas being open to all nations, no State may validly purport to subject any part of them to its sovereignty."

See also Declaration of Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, Beyond the Limits of Natural Jurisdiction, UN.NG.A. Resolution 2749 (XXV) adopted Dec. 17, 1970.

> 1. The sea-bed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction (hereinafter referred to as the area), *as well as the resources* of the area, *are the common heritage of mankind.*
>
> 2. The area shall *not be subject to appropriation* by any means by States or persons, natural or juridical, and *no State shall claim or exercise sovereignty* or sovereign rights over any part thereof.

Id. (emphasis added).

111. New areas of human concern and activity will create awareness of new problems in international law, yet there is no reason for believing that international law is spatially restricted. The General Assembly of the United Nations has adopted the view that international law, including the Charter of the United Nations, applies to all space and celestial bodies. *See* Treaty on Principles Governing the Activities of State in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Resolution 1721 (XVI) adopted 20 Dec. 1961.

112. Ojos del Salado, Chile's highest mountain, is 22,539 ft. or approximately four miles above the Chilean coast. NEW COLUMBIA ENCYCLOPEDIA 533 (W. Harris & J. Levey eds. 1975).

113. The central mountainous belt of Nepal ranges between 1000 and 8000 ft. above sea level, as much as five miles below Annapurna II (26,041 ft.), Makalu (27,790 ft.), and Everest (29,028 ft.). 16 ENCYCLOPAEDIA BRITANNICA 221 (1972).

national ownership of the interior of mountain ranges. It might be urged that adjustments around these geologic peculiarities can be made in much the same manner as the law of the sea has yielded oceanic territory within certain large, "historic" bays to nations.[114] The mountain territory could, by definition, be an "historic" exception and would remain under sovereign jurisdiction of the superjacent state.[115]

B. Delimitation at a Set Depth Below Sea Level

It might also be suggested that a fixed distance of delimitation be set at a specific depth below sea level. By such a standard of delimitation, nations would own their territory uniformly to an agreed depth below sea level. Such a measure would render sovereign all of a state's visible territory at altitudes above sea level. This approach would eliminate any problem of commonly shared subterrestrial territory existing above any portion of a state's lowlands.

A low-lying nation, such as the Netherlands, however, would command subterrestrial territory of less than three miles due to subsea-level surface.[116] The Netherlands and other states disadvantaged by their terrain would probably assert claims not unlike those of the "geographically disadvantaged" states which do not share the full rewards of territorial sea and continental shelf ownership.[117]

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114. Article 7(6), Convention on the Territorial Sea and Contiguous Zone, *supra* note 12. The "historic" bay concept preserved to the sovereign as internal waters the areas inside certain bays. A similar rationale could provide an exception in the law of subterrestrial delimitation, preserving for the sovereign areas within the historically claimed mountain ranges. *Id.* art. 7(4). *See* art. (7), which describes drawing a baseline to enclose the internal waters. A comparable baseline could be drawn at the lower extremity of mountain ranges to "enclose" them within the sovereign's territory.

115. For an example of the application in a national court of the criteria of qualifying as a historic bay, see United States v. Alaska, 422 U.S. 184 (1975). It is clear that international law guidelines for qualifying historic bays as inland waters of the adjacent state would not literally translate into a formula for designating the interior of mountain ranges as a superjacent state's territory. A parallel rationale, however, one which would attempt to reconcile ownership inside major mountain ranges with surface ownership, seems to be a predictable likelihood.

116. Forty percent of the Netherlands surface territory is subsea level. *See* NEW COLUMBIA ENCYCLOPEDIA, *supra* note 112, at 1912. As one can note (*see infra* Diagram II) the isostatic depth of the crust below the Netherlands would be correspondingly shallow, rendering that state disadvantaged in terms of its subterrestrial ownership of crustal resources.

117. Subterrestrially deprived nations may seek to claim more than their natural amount of subsurface territory. Their plight might result in a desire to share the more abundant subterrestrial resources of neighboring states. As is the case when comparing subterrestrial claims within mountains to existing international law embracing historic bays, the analogy is dangerous due to its lack of precise parallel. However, a nation which senses it does not share favorably in its access to resources, may seek to enlarge or equalize its claims in order

Equitable apportionment could be imposed which would compensate for the natural subterrestrial landmass deficiencies of a nation. The International Court of Justice has used equitable principles to avoid the harsh results that would otherwise arise from a rigid application of delimitation rules related to the continental shelf.[118] Similar potential miscarriages of justice could be circumvented by equitable relief in the world court.[119]

Total reliance upon the judiciary to overcome discrepancies in a delimitation principle, however, is both tedious and precarious. It is also complicated by the historical belief that states own all the territory below their surface borders. Nations may argue that a longstanding belief of ownership, unchallenged by other states, could give rise to prescriptive claims—ones far deeper than any suggested standardized depth.[120] Belief alone, unaccompanied by action in response to the his-

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to overcome the disadvantage. Extreme geologic deprivations exist for the landlocked nations, those without seaports. Disability also exists for the geographically disadvantaged nations, those with minimal access to the sea. *See* UNCLOS III, *supra* note 94, art. 69, which attempts to secure for the geographically disadvantaged nations an equitable portion of living resources in the same region or subregion.

118. Article 6(2) of the Convention on the Continental Shelf, *supra* note 12, provides:

> Where the same continental shelf is adjacent to the territories of two adjacent States, the boundary of the continental shelf shall be determined by agreement between them. In the absence of agreement, and unless another boundary line is justified by special circumstances, the boundary shall be determined by application of the principle of equidistance from the nearest points of the baselines from which the breadth of the territorial sea of each State is measured.

The International Court of Justice, in circumventing rigid application of art. 6(2), delimited the continental shelf between the competing nations by use of equitable considerations. North Sea Cases, *supra* note 8. The important lesson here, for subterrestrial delimitation purposes, is that a treaty which specifies a formula for delimiting territory does not guarantee a judicial result. It can be anticipated that even upon securing an international treaty embodying a formula or method of subterrestrial delimitation, special circumstances, other demands of equity, or the extent of customary law will find delimitation by other than purely mechanical applications.

119. There exists the possibility, though not high probability, that disputes between nations related to subterrestrial delimitation would, upon agreement between the party nations, be determined in equity. International Court of Justice Statute, art. 38(2) provides: "This provision shall not prejudice the power of the Court to decide a case *ex aequo et bono* if the parties agree thereto." This provision, however, does not obviate the need to develop a workable formula in international law to delimit the subterrain; but, it does provide additional legal dimensions through which to adjudicate the limits in the presence of a formula.

120. The notion of subterrestrial land being acquired through prescriptive claim is a matter of analogy more than precedent.

It is clear that no state has totally usurped the land under another nation absent taking of the surface property.The realization, however, that longstanding, unchallenged belief in ownership is akin to a prescriptive claim, is a comparison worth making, as Professor D.H.N. Johnson states that

> '[a]cquisitive prescription' is the means by which, under international law, legal

torical claim, is a weak argument.[121] Historical use of territorial waters has resulted in the International Court of Justice considering extended territorial claims to the sea.[122] Historical belief in deep subterrestrial jurisdiction, however, has not coincided with actual "use," unless it is argued that the subterrestrial territory was "used" as support for the nation's landmass.[123]

Delimitation at a mechanically set subsurface distance is troublesome in other ways. Unlike the atmosphere, which offers specific equidistant strata near the earth,[124] subterrestrial territory offers few equidistant strata near the surface. The depth of the mineral-rich crust

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recognition is given to the right of a state to exercise sovereignty over land or sea territory in cases where that state has, in fact exercised its authority in a continuous, uninterrupted, and peaceful manner over the area concerned for a sufficient period of time, provided that all other interested and affected states (in the case of land territory the previous possessor, in the case of sea territory neighbouring states and other states whose maritime interests are affected) have acquiesced in this exercise of authority. Such acquiescence is implied in cases where the interested and affected states have failed within a reasonable time to refer the matter to the appropriate international organization or international tribunal or—exceptionally in cases where no such action was possible—have failed to manifest their opposition in a sufficiently positive manner through the instrumentality of diplomatic protests. The length of time required for the establishment of a prescriptive title on the one hand, and the extent of the action required to prevent the establishment of a prescriptive title on the other hand, are invariably matters of fact to be decided by the international tribunal before which the matter is eventually brought for adjudication.

Johnson, *Acquisitive Prescription in International Law*, 27 BRIT. Y. B. INT'L L. 332, 353-54 (1950).

121. One of the forms of prescription recognized in international law is "immemorial possession," the unchallenged long-term belief in ownership of possessed territory. For a discussion of the existing views, their divergence, and the major cases from which the prescriptive rationale springs, see I. BROWNLIE, *supra* note 54, at 157-64.

122. See Fisheries Case (U.K. v. Nor.) 1951 I.C.J. 116, 138-39, for the theory of "historical consolidation," which can render a territorial claim enforceable against other states.

123. The rights of surface owners to support from land laterally or subjacently is recognized in national law. For a discussion of both the English and American views, see 1 AM. JUR. 2d, *Adjoining Landowners* §§ 43-66 (1962). Particular problems are created when one attempts to impose internationally the rationale of support embraced in domestic legal systems. The problems are both legal and physical. Physically, it is doubtful that a state, such as Liechtenstein, would "fall" absent ownership to the center of the earth. It would likely be sustained in the fashion of a bridge supported laterally. Legally, the issue of ownership based on the need for support is remote from any actual international case or controversy, making the theory of ownership based on need for support a pure conjecture rather than a legally resolvable situation as exists in domestic law disputes.

124. The atmosphere is divided in specific layers, identified top (at approximately 250 miles) to bottom as the exosphere, ionosphere, stratosphere, and troposphere. There is some variation in the tropopause, which is higher near the equator and lower near the poles, a variation from approximately 25,000 to 59,000 feet. *See* II ENCYCLOPAEDIA BRITANNICA 701-2 (1968); THE RANDOM HOUSE ENCYCLOPEDIA 212 (1977).

of the earth varies greatly.[125] An attempt to equate ownership of the subsurface with that of the stratosphere lacks an exact medium of translation.

Nations have experienced particular difficulty in agreeing upon standard distances for their sovereign territorial seas.[126] Standardized depths of assigned jurisdiction for states in continental shelves have also proved elusive.[127] It is likely that any attempt to establish a set depth of subsurface sovereignty within the earth will prove to be at least as complex and problematic.

C. Delimitation Related to Technology

The Romans maintained that the ability to control the surface of the sea granted them ownership of the territory below the sea.[128] Roman technology, namely military boats, made such a theory practical at

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125. *See infra* DIAGRAM III.

126. To the degree nations do succeed in establishing standard distances, the International Court of Justice has not been able to elevate the standards to status of general rules of international law. As former I.C.J. Judge, Sir Hersch Lauterpacht, commented:

> [In] the *Anglo-Norwegian Fisheries* case the Court declined to admit that there existed a general rule of international law prescribing that the base-line of territorial waters must follow sinuosities of the coast. Similarly, it refused to concede the existence of a general rule of international law laying down a ten-mile limit for the base-line of territorial waters in the case of bays. With regard to both principles there had crystallised, prior to the Judgment of the Court in the *Fisheries* case, a preponderant, though not a uniform or universal, practice. The Court declined to treat that practice as expressive of a binding rule of international law. In the case of the coast line it based its denial of the existence of a binding general rule on the numerous exceptions in the application of the rule and on the diversity of the methods employed. In the case of bays the Court stated that "although the ten-mile rule has been adopted by certain States both in their national law and in their treaties and conventions, and although certain arbitral decisions have applied it as between these States, other States have adopted a different limit" and that "consequently the ten-mile rule has not acquired the authority of a general rule of international law."

H. LAUTERPACHT, THE DEVELOPMENT OF INTERNATIONAL LAW BY THE INTERNATIONAL COURT OF JUSTICE 369-70 (1958).

127. In the 1958 Geneva Convention on the Continental Shelf, art. 1, states that

> [f]or the purpose of these articles, the term 'continental shelf' is used as referring (a) to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a *depth of 200 metres or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation* of the natural resources of the said areas; (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands.

(Emphasis added.) The standard depth of 200 meters is all but destroyed by tying it to an elastic variable of technology, the depth to which superjacent waters are capable of being exploited.

128. *See* Marston, *supra* note 8, at 321.

that time. This rationale of equating control and ownership supported the legal tradition, which equated ownership of territorial seas to a state's firepower.[129]

Similar attempts have been made to equate the limits of airspace with the technological ability of man to penetrate airspace.[130] It was seriously hypothesized that certain technological phenomena would provide a workable means of establishing the limit of sovereignty in airspace. For instance, it has been suggested that the maximum altitude at which aerodynamic lift occurs could suffice as the boundary between airspace and outer space.[131]

The problem with most technological theories is the variable nature of technology. Even the limit of aerodynamic lift, once thought stable, was foiled by the antipodal airplane's[132] ability to bounce off the atmosphere, thereby scaling heights thought unattainable by aerodynamic lift alone. Recently, the efforts of the United States to develop a space shuttle have compounded the awareness, already present in the aerospace industry, that technological limits are subject to dynamic expansion.[133]

Man has not yet evolved a technology for sending vehicles to great depths within the earth. If it were suggested that the current ability to drill below the surface could provide a basis for determining sovereignty, it could safely be presumed that future technology will provide a means to penetrate to much greater depths and hence produce variable limits upon sovereignty. Perhaps a sound lesson learned from both the laws of the sea and of space is that technology provides surprises and unforeseen complications when used to determine the extent of a nation's sovereignty.

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129. C. VAN BYNKERSHOEK, *supra* note 64, at 43.

130. Newton, *supra* note 63, at 403. S. LAY & H. TAUBENFELD, *supra* note 61, at 41-51, trace significant technological penetrations of the atmosphere and the limitations of attempting to tie delimitation to the particular phenomena. Lay and Taubenfeld offer a thorough review of the hopes and foibles of technological consideration in attempts to delimit the atmosphere and outer space. The observations are enriched with dozens of citations to multiple theories which, while exhausting the technologies usable for delimitation, create an exhausting list of weaknesses in any and all proposals.

131. S. LAY & H. TAUBENFELD, *supra* note 61, at 45.

132. The Sanger-Bredt Antipodal Bomber is one of many hybrid vehicles discussed in Sloup, *supra* note 61, at 419-20.

133. For a full treatment of most conceivable theories and views of different nations, see G. GAL, *supra* note 22, at 70-98.

Pictorial renditions can be found at 77, 80, 83, and 88. "A. Meyer admitted in 1965 that, in spite of researches, the boundaries could not be drawn according to any geographical or topographical parameters, or on the basis of technical properties (*e.g.*, the character of the flying objects), because these, too, were subject to a continuous change." *Id.* at 98.

The inherent weakness of delimitation based on technology is the fact that technology has limits at a given point in time which may be undermined by later developments. Despite this inherent defect, one finds international lawyers willing to entertain technology as a means by which to establish international jurisdictional limits.[134] In the 1958 Law of the Sea Convention on the Continental Shelf, the limit of the shelf was designated as being the depth at which exploitation of the natural resources could take place, an obviously variable frontier.

D. Delimitation Related to National Circumstances

An argument could be made that the depth of one nation's subterrestrial sovereignty does not necessarily need to be equal to another nation's claims. Just as some nations have maintained extensive sea claims[135] while others have made minimal claims, a state's subterrestrial claim might be allowed to vary as against that of another nation. The circumstances causing such variance might be economic, historic, security-related, physical, or a combination of several or all of these factors. A small or middle-sized state (one such as Switzerland, sandwiched between superpowers) might seek to reinforce its sense of security and neutrality by placing other nations' interests as far away as would be tolerated, hence, at as great a depth as possible. This can be compared to the extended claims of certain South American countries for protecting their fishing resources over abnormally broad territorial seas.[136]

Economic pressure has caused small nations such as Iceland to extend territorial sea sovereignty,[137] while others such as Japan have, for

134. *Id.* at 70-98. It is not suggested that failure to create a precise point of demarcation renders efforts in treaties or other understanding illusory. The fact that an attempted point is suggested, albeit flexible by definition, creates some understanding of the approximate intentions of parties. The approximate points of demarcation focus attention on given points even though the point is not precisely determinable under all circumstances.

135. *"Breadth of the Territorial Sea.* This is a question on which there is no general consensus on the part of governments and an understanding of present difficulties may be gained only by an examination of the historical evolution of the territorial sea." I. BROWNLIE, *supra* note 54, at 191. Some nations have claimed up to 200 miles, while others have remained within the traditional three miles. The extended claims, primarily of certain Latin American countries, have been targeted at preserving certain whaling and other fishing interests. *See* D.J. HARRIS, *supra* note 80, at 369-77. There has been some attempt to create technical demarcation at the 200 mile limit. *See* Hollick, *The Origins of 200-Mile Offshore Zones*, 71 AM. J. INT'L L. 494 (1977).

136. Hollick, *supra* note 135, at 495-96.

137. *See* Fisheries Jurisdiction (U.K. v. Ice.) 1974 I.C.J. 3, 24. Iceland announced a 50-mile exclusive zone for fishing, a distance approximating Iceland's continental shelf. The United Kingdom protested and filed an application with the International Court of Justice

different economic reasons, pursued narrow territorial seas.[138]

The need to protect national interests, whether perceived as economic or aesthetic, security-related or historic, could evolve subterrestrial claims which would vary greatly. This result is not desirable from a systematic juridical standpoint, yet it is a possibility from an historical vantage.

VIII. ELEMENTS OF WORKABLE DELIMITATION FORMULAE

A. Axioms of Land, Sea, and Space Law

As previously discussed, delimitation theories based on set distances below the surface, preordained distances below sea level, set limits of technology, or variable national needs, are all problematic. Other mechanical or political formulae for delimitation could be suggested. At this juncture, however, it is more helpful to state criteria of successful delimitation rather than exhaust all potential theories. For instance, any suggested subterrestrial delimitation theory which totally or partially contradicts the rationale of existing sea or space law is objectiona-

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in April 1972. In July 1972, Iceland made regulations carrying out its intent. Thereupon, the United Kingdom sought, and obtained, interim measures of protection from the court. Pending the outcome of the case, Iceland was called upon to refrain from enforcing its 1972 regulations, and the United Kingdom was called upon to limit its annual catch to 170,000 tons (it had asked for 185,000). When Iceland ignored the Court's order, the United Kingdom again protected its fishermen in the second "Cod War." In November 1973, an interim agreement was reached by which the United Kingdom was allowed to take 130,000 tons from the zone for the next two years. In February 1973, the court had found that it had jurisdiction to hear the application. The court ruled on the merits of the case in the present judgment in July 1974. It tacitly recognized the United Kingdom's fishing rights and held that both countries were under mutual obligations to undertake good faith negotiations for an equitable solution. *Id.* at 34.

138. Japan has traditionally reaped economic benefit as its expert fishing fleets have penetrated waters of other nations around the world. It is clear Japan favors legal limits which allow maximum accessibility of its fleets to fishing resources adjacent to other nations. The careful balance struck between Japan's traditional access within what is now claimed to be territorial water can be seen in the agreement struck between the United States and Japan in the *Governing International Fishery Agreement with Japan*, H.R. Misc. Doc. No. 168, 95th Cong., 1st Sess. 3 (1977), which states in art. V.:

> In determining the portion that may be made available to fishing vessels of Japan . . . the Government of the United States shall promote the objective of optimum utilization and shall take into account *inter alia* traditional fishing by nationals and vessels of Japan, contributions to fishery research and the identification of stocks by Japan, previous cooperation by Japan in enforcement and with respect to conservation and management of fishery resources of mutual concern, and the need to minimize economic dislocation in cases where fishing vessels of Japan have habitually fished for living resources off the coast of the United States.

ble.[139] Contradicting formulae would ipso facto defeat concepts of world order.[140]

One element of a workable subterrestrial delimitation is harmony—a working compatibility with law delimiting the sea and space.[141] A theory that would reflect similarity with existing delimita-

139. The law of the sea and air law have not coincided perfectly, yet they do coexist. The coexistence is possible due to their general compatibility. The attempts to increase harmony between sea and air law are among the neglected issues of international law. *See generally* J. GAMBLE, LAW OF THE SEA: NEGLECTED ISSUES 122 (1979), in which Professor Christol noted:

> The emerging international law of the sea will influence the transit of aircraft in ocean airspace. This assessment seeks to portray emerging trends respecting the present and future use of such airspace.
>
> Certain complex social forces will condition expectations relating to the use of such airspace. Among such forces are the continuing discoveries and innovations of science and technology, the increasing needs to facilitate the long-distance movement of individuals and their goods, comparative financial costs for such services, on-going concerns for national security, and the constant demand for the discovery and use of natural resources. Air traffic continues to increase as man engages in a more intensive exploitation of the ocean's living resources, the oil and gas lying beneath the territorial waters, contiguous zones, and continental shelves, and the gathering in the future of the manganese nodules and other resources lying within the 'Area' proposed in the Informal Composite Negotiating Text of the United Nations Third Conference on the Law of the Sea (ICNT, 1977). Affecting each of the identified forces, and there are many other such influences, is the fact of the rapidity of change, the quantum jumps which are the scientific and possibly political hallmark of the 20th century.

The same awareness of social, political, and technical factors needs conciliation upon adding the third regime to the existing air and sea law, namely, the regime of subterrestrial law.

140. *Id.* at 135. Professor P. Heller recognized the desirability of harmonizing regulations, stating:

> In order to prevent collisions in the over-crowded parts of the world, sea, road and air traffic require uniform regulation within states, and on a supranational level in respect of activities extending beyond national boundaries. These technical regulations must keep in step with the development of technical knowledge and experience. This requires a method of adopting and amending technical regulations which eliminates time-consuming formalities to the greatest possible extent.

141. Professor K. Hailbronner has voiced concern for carryover between air and sea law, a recognition that concepts of air freedom must blend with designated freedoms of the sea in a manner which is functional:

> [T]here is the concept of the Chicago Convention that the airspace above the high seas is free. And I would like to remind you in this context that freedom of the airspace is not limited to a right of overflight only. It is really much more. It is an establishment of a free area not subject to any national restrictions with regard to airspace. Here in the Netherlands, a country that has traditionally upheld very strongly the concept of the freedom of the airspace, I believe that this traditional customary rule of international law is a requirement that we should not give up very easily.

Id. at 54.

In order to carry Professor Hailbronner's suggested harmony to the third dimension,

tion law is desirable.

A second element of satisfactory delimitation is uniformity. A desirable formula is one that would be capable of application to most nations without unreasonable variation or exception. A law of delimitation that in application greatly favored certain nations and prejudiced others would lack acceptability and would therefore be undesirable.

A further criterion for acceptable delimitation is understandability. A formula will be preferable to the extent that it is readily understandable and clear for purposes of both application and enforcement. Perhaps no aspect of the law of the sea has provided more problems than the failure to create[142] a clear guideline for delimiting nations' territorial waters. Delimitation of space involves a similar lack of precision in definition. It is only in the extreme that a state has been certain of its sovereign limits.[143]

A final element for a practical delimitation theory is naturalness, the tendency of the formula to possess compatibility with nature. For instance, naturalness would be present if territorial seas were directly related to the extent of the underlying continental shelf, or if the line of legal demarcation between the atmosphere and outer space were related to the presence of a certain concentration of air molecules. A theory which at least tends in the direction of compatibility with nature is desirable over delimitation mechanics that totally ignore natural phenomena.[144]

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that of including subterrestrial areas, the rational extension of his argument would be to insist upon total freedom of the deep subterrain in all areas under high seas.

142. It is not being suggested that the lack of delimitation is an oversight. The territorial water disputes in international law are the result of immense factual and legal complexity, the extent of which is best appreciated by review of the major territorial sea dispute, Fisheries Case (U.K. v. Nor.) 1951 I.C.J. 116. Note the lack of precise definition in the 1958 Geneva Convention on the Law of the Sea, which merely states: "The sovereignty of a State extends, beyond its land territory and its internal waters, to *a belt of sea adjacent to its coast described as the territorial sea*," Convention on the Territorial Sea and the Contiguous Zone, art. 1, *supra* note 12 (emphasis added). *See generally* O'Connell, *The Juridical Nature of the Territorial Sea*, 45 BRIT. Y.B. INT'L L. 303 (1971).

143. *See supra* note 76.

144. The 1958 Geneva Convention on the Law of the Sea exhibits concern for alignment of jurisdictional limits coincidental with natural phenomena. *See* Convention on the Territorial Sea and the Contiguous Zone, art. 3-11, *supra* note 12, which attempts to tie the territorial waters to natural phenomena such as low-water lines, land above water at high tide, distance across bays, and low-tide elevations. *See* Convention on the Continental Shelf, art. 1, *supra* note 12, stating:

> For the purpose of these Articles, the term "continental shelf" is used as referring (a) to the *seabed* and *subsoil* of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a *depth of 200 metres* or, beyond that limit,

The ideal delimitation formula would thus be in harmony with existing sea and space law, prove uniform in application to the many nations, be exact and easily understood, and tend to be compatible with nature. Can any theory of subterrestrial delimitation be suggested which meets or even approaches satisfaction of these elements of a workable delimitation formula?

B. The Phenomenon of Isostasy[145]

Before seeking a delimitation formula that would prove uniform, explainable, natural, and in accord with oceanic and space law, additional geophysical facts need acknowledgement.

As previously noted, the crust of the earth varies in thickness. The crust may be more than forty miles thick under portions of continents and five or fewer miles thick under the oceans.[146] This crust, contrary

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to where the *depth of the superjacent waters admits of the exploitation of the natural resources* of the said areas; (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands.

(Emphasis added.) Attempt to tie space delimitation to natural and other phenomena is noted *supra* note 51.

145. *See infra* Diagram III.

146. As noted *supra* Diagrams I & II, the major subterrestrial divisions of the earth are the crust, mantle, and core.

> The thickness of the crust varies from about 35 kilometers to 10 kilometers in a section extending from continent to ocean. Under a high mountain the crust thickens to as much as 65 kilometers . . . [which] suggests to the reader that the continental crust floats on the denser mantle like an iceberg on the ocean. . . . Icebergs float because they are less dense than sea water; flotation comes from a large volume of ice that lies below the sea surface. When Archimedes' principle of buoyancy is applied to the flotation of continents and mountains, it becomes the *principle of isostasy*, which holds that the relatively light continents float on a more dense mantle; most of a continent's volume lies below sea level for the same reason that most of an iceberg lies below the ocean surface. Nature has contrived that large topographic loads like mountains and continents are compensated—that is, supported primarily by buoyancy rather than by the strength of the crust. Rocks, which we know to be solid and strong over the short term (seconds or years), are weak and flow like a viscous fluid when loaded over the long term (thousands to millions of years). When continents grow or mountains are pushed up, a supporting root must develop as part of the process to provide buoyancy and keep the new load from sinking. One variant should be mentioned. If for some reason—for example, regional heating—a part of the upper mantle becomes less dense than the adjacent mantle, it will also exert a buoyant force that can support elevated topography above it without the need for a crustal root. In a sense, the lower-density mantle serves as a root.

EARTH, *supra* note 15, at 428-31.

to common sense belief, is "floating" rock. It is material of lesser density than the flexible material upon which it floats.[147]

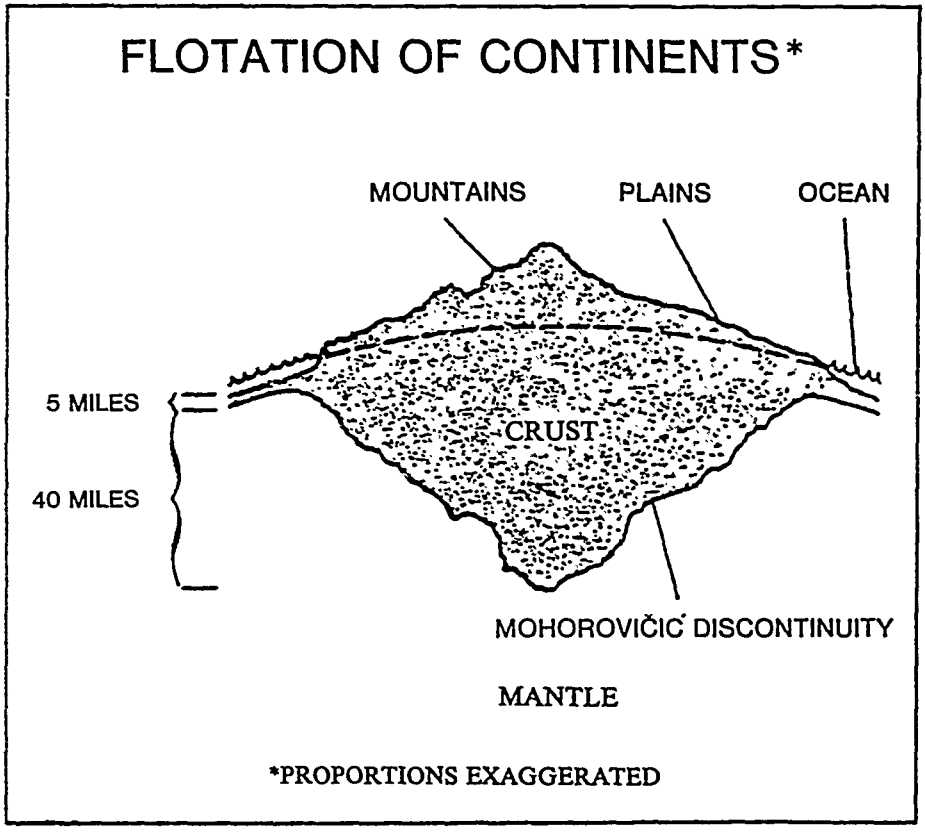

DIAGRAM III

Depiction composed from H. TAKEUCHI, S. UYEDA, H. KANAMORI, DEBATE ABOUT THE EARTH 31-39 (1967); A. COX, PLATE TECTONICS AND GEOMAGNETIC REVERSALS 35-37 (1973); F. PRESS & R. SIEVER, EARTH 428-32 (2d ed. 1974).

The crust floats on the denser mantle below in a manner similar to an iceberg floating on the ocean. The higher the iceberg extends above the surface of the water, the deeper, in exaggerated proportion, it ex-

147. For a more complete description of Archimedes' principle, see DEBATE, *supra* note 15, at 32.

tends beneath the sea. The higher the crust's continental mountain ranges extend, the deeper its subterrestrial, downward extension reaches. The geologic term for this phenomenon is isostasy.[148]

C. Seismologic Discovery: The Mohorovičić Discontinuity

In 1909, a Yugoslav seismologist, Andrija Mohorovičić, made a discovery which has become a geological classic.[149] He found while studying a Balkan earthquake that the seismic waves behaved in a manner which indicated an abrupt change in subterrestrial material at a certain depth. The depth at which he found the change to take place was approximately thirty-five miles below Yugoslav land surface.[150] The same phenomenon, now universally called the "Moho," has been observed at multiple points around the earth. The Moho discontinuity, as the inferred change of rock structure is called, is generally accepted as being the point at which crust ends and the lithosphere, the uppermost portion of the mantle, begins.[151]

The Moho discontinuity, in short, represents a widely accepted subsurface point at which surface rock structure ends and deep mantle structure begins. The Moho has been well substantiated by seismic testing.[152] It has never been directly visible, although an unsuccessful

148. "This notion of 'floating continents,' the apparent balance between the weights of the oceanic and continental columns, is called *isostasy*." O. PHILLIPS, *supra* note 16, at 119.

149. In 1909, there was a shallow earthquake in Croatia. Later, in Zagreb, Mohorovičić noticed something curious while studying the records of this earthquake. At a certain distance from the focus, waves arrived as they should, but a short time later a second pair appeared. There was no doubt that there had been only a single shock. It was rather like an echo, but what in the earth would produce an *echo* of these waves?

Echoes are most familiar when sound is reflected from a steep rock cliff, or the blank wall of a building. However, a surface need not be hard to produce an echo. Underwater sound reflects from the surface of the ocean very well, giving underwater echoes that can confuse sonar operators. The important thing is that the sound should encounter a sudden change in the nature of the material and in the speed of propagation from one side to the other—whether from air to rock or from water to air. Mohorovičić realized that the apparent echo could be explained by a sudden change in the nature of the rock some distance down in the earth, by a discontinuity of some kind. He calculated that this discontinuity, or change in structure, was at a depth of about 60 km, in Yugoslavia at least. The discontinuity that he discovered now bears his name. *See* EARTH, *supra* note 15, at 428; O. Phillips, *supra* note 16, at 112.

150. O. PHILLIPS, *supra* note 16, at 114.

151. "We do find a reflector beneath the continent, but it is generally only about 30-35 km deep, and the boundary seems to carry on into the oceanic area at a depth below the ocean floor of only 5 km. This boundary is the so-called Moho. Moreover, the seismic velocities suggest that the lower continental crust is seismically similar to the oceanic crust and the entire crust lies on a more dense material, the mantle. . . ." J. ELDER, *supra* note 18, at 19.

152. Seismologists have developed a specific field procedure for scientific measurement

attempt (the "mohole") was made to drill to it.[153] As a seismic confirmation of isostasy, the Mohorovičić discontinuity can be traced below continents and ocean floors with considerable accuracy. The Moho forms an "echo" which broadcasts the depth of a continent, and it offers promise as a useful indicium in delimitation.

The Moho discontinuity is an attractive candidate for the physical aspects of delimitation. It does not, however, provide the *total* legal solution.[154] The political activities of nations have demonstrated that nations will not tolerate a single abrupt delimitation designating transition from total sovereignty to no sovereignty. The attempt to extend a limited form of national control is evident in the "contiguous zone" beyond territorial seas and on the "continental shelf" below and beyond territorial seas.[155] Also, recent United Nations efforts have suggested a theory of "exclusive economic zones," granting the sovereign nation extended and exclusive rights in exploiting certain resources adjacent to and beyond territorial seas.[156]

1. A Subterrestrial Contiguous Zone

It is doubtful that nations, some of which have surface territory of hundreds or thousands of square miles, would accept an abrupt and total delimitation at the Moho from levels of four to fifty miles beneath the surface. It is likely, as with the existing and proposed law of the sea, that states would seek a deeper, though partial, extension of their jurisdiction. The underbelly of a nation would incite concern over defense vulnerability. A zone of safety, contiguous to and below the nation's crust, could be designated as exclusive domain as against any other nation's military uses. Distinguishing between military and peaceful uses is problematic, yet not more so than that already encoun-

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of the crust's thickness. The procedure is activated by an induced seismic shock, an explosion, the seismic waves of which are measured at strategic points. For a pictoral and mathematical explanation of the procedure, see EARTH, *supra* note 15, at 430.

153. O. PHILLIPS, *supra* note 16, at 115.

154. The fact the Moho discontinuity can be located with regularity and predictability under the oceans and under continents does not mean it forms a precise, exact line. Geologists find that the Moho marks an area of transition which is definable *within 1 km* of accuracy. J. ELDER, *supra* note 18, at 211.

155. *See* Convention on the Territorial Sea and the Contiguous Zone, *supra* note 12, art. 24; Convention on the Continental Shelf, *supra* note 12, art. 1.

156. *See* UNCLOS III, *supra* note 94, part V, art. 55-75. The exclusive economic zone is not intended to extend beyond the territorial sea for more than 200 miles, and the basic resources sought to be protected within the zone are anadromous stocks, catadromous species, marine mammals, and others. The extensive text, including treatment of artificial islands, the continental shelf, and tunneling, is best reviewed *in toto*.

tered in space and under the sea.[157] The exact depth of the contiguous zone of defense could be based on any one of several rational theories.[158]

A subterrestrial exclusive economic or safety zone could exist directly below the crust, an area in which only the superjacent state would have the right to explore and exploit certain resources. The rationale for an extensive subterrestrial economic zone appears to be less persuasive than an exclusive subterrestrial defense zone.[159] Whatever the eventual depth decided upon, it is apparent that some contiguous extension, particularly for defense purposes, may be insisted upon by the states.

2. The Moho Line as the Subterrestrial Limit of Sovereignty

This Article suggests that a workable law of subterrestrial delimitation must possess certain elements. The law needs to be blended with existing international law of the sea and space. The law would more likely find acceptance and success if it were readily understandable and if it were a clear formula capable of uniform application among the states. It has also been suggested that the law would work best if it were compatible with nature (patterned after natural phenomena) rather than being based upon abstract invention. The Mohorovičić dis-

157. The question of what would constitute "innocent" presence or "hostile" presence within the contiguous zone might find some guidance in the Convention on the Territorial Sea and the Contiguous Zone, *supra* note 12, section III, Right of Innocent Passage, wherein it is stated, "Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State." *Id.* art. 14. However, the ripening of "innocent" presence into "hostile" acts is well-known in international transactions, and despite well-intended definition, will be difficult to detect and enforce. The problem will be the traditional one, that of forestalling invasion and occupation. *See* LORD MCNAIR & A. WATTS, THE LEGAL EFFECTS OF WAR 376-79 (1966).

158. The difficulty in agreeing upon the appropriate depth will likely entail what specific nations envision as their unique needs within contiguous subterrestrial areas. Analogy is available in Canada's attempt to secure contiguous sea areas for arctic pollution control, and in British attempts to define fishing rights adjacent to other nations. *See* G. SMITH, RESTRICTING THE CONCEPT OF FREE SEAS 22 (1980), wherein it was noted:

> Under a variety of labels, such as "contiguous zone," "customs area," "defensive area," "conservation zone," and "zone of neutrality," states exercised an acknowledged competence to declare the existence of these zones and to function within them. Some states chose to claim these zones as extensions of their territorial waters. Others merely sought to safeguard certain special rights over parts of the seas through them.

159. As noted, *supra* note 156, the exclusive economic zone law of the sea is created in large extent to protect living resources, a concern not present in subterrestrial law. The concerns for pollution and for defense, however, remain. One noteworthy example would be the subterrestrial positioning of nuclear weapons.

continuity, as a point of subterrestrial delimitation, appears to come close to fulfilling the desired elements. The Moho line is based on a natural phenomenon, a discontinuity thoroughly established and readily observable below all of the world's continental, island, shelf, and seabed areas.[160] It is a natural geologic phenomenon that reflects the subterrestrial limit of the earth's crust with considerable uniformity. The line provides a general mirror image of the superjacent surface, being deepest below mountains and shallowest under plains, continental shelves, and seabeds.[161]

As a time-proven geologic discovery, resubstantiated from many vantage points over many decades, the Moho line is geophysically established and understood. The subterrestrial measurement of a state's sovereignty to the Moho line would provide a uniform formula for exclusive jurisdiction of a state over all of its subterrestrial crust. The measurements to the Moho line could be tethered to international law of the sea, in that coastal states could measure their territorial sea claims downward through crust layers to the Moho. Nations with claims to continental shelf beyond their territorial seas could claim exclusive jurisdiction to the Moho line below their respective shelves. The deep seabed under the high seas, not only to the Moho line but beyond to the earth center, would remain *res communis*—territory common to all mankind.

The Moho line, as an international point of subterrestrial delimitation, could be adopted through convention. An international conference similar to the Conference on the Law of the Sea may be required. The Conference on Subterrestrial Delimitation could entertain the logistics of partial sovereignty, extended beyond the Moho into the earth's mantle, for defense or other purposes.

IX. CONCLUSION

It is not the purpose of this Article to exhaust the issue of subterrestrial delimitation, nor is it suggested that the Moho line, or even the stated elements of a workable inner-earth delimitation, will prove durable. What must be appreciated is the fact that subterrestrial delimitation, an unasked juridical question, must not remain unanswered. Subterrestrial delimitation is a vital and overlooked issue in international law.

Delimitation, by definition, imposes a severe restriction on our

160. *See supra* notes 152 & 154.
161. *See supra* Diagram III.

sense of ownership. As previously discussed, animals and men share strong instincts related to territory, and the territory which is underfoot incites some of the strongest feelings of territoriality and ownership. It was not unpredictable that early man adopted the rationale of *cujus est solum, ejus est usque ad coelum et ad inferos*. The need to own everything above and below one's land without limit seemed natural and mandatory. The Roman maxim was adopted and applied through the ages and was retained long after the earth was found to be spherical.

The division of the earth's surface among sovereign states has resulted in considerable international agreement as to the commonly used airspace and oceans. Increased scientific understanding of the inner earth and heightened technology allowing penetration into the earth will eventually prompt man to conquer all or most of the inner earth. This prospect heightens both curiosity about and need for jurisdictional clarification. The earth's inner resources, specifically space, energy, and minerals, will prove to be of vital importance in future centuries. The rules which will guide deep earth exploration, slant drilling, and military uses will all require legal guidelines presently not in existence.

The rationale for considering the bowels of our planet to be a common heritage of all mankind is strong. Precedent for this approach is found both in the law of the sea and in the law of space. Mass territories beyond a nation's immediate boundaries are not, in modern international law, objects of acquisition.

The scientific discoveries of this century, as further defined in recent years, point to the Mohorovičić discontinuity as a candidate upon which to vest delimitation. Assigning to the Moho line the distinction of separating a state's sovereign crustal territory from nonsovereign inner earth seems logical, both in terms of geologic phenomena and the needs of international law. The Moho line provides a formula of uniform application which is understandable and equitable among the nations. In addition, the Moho line can be tied into both the existing and the emerging law of the sea.

X. POSTSCRIPT: AN INVITATION TO FURTHER INQUIRY

This Article has suggested that a geological phenomenon, the Moho line, provides a meaningful basis for subterrestrial delimitation. Whether future events prove the Moho discontinuity to be a worthwhile delimitor remains to be seen. What is certain is that the Moho

line theory, or any other formula, will encounter serious problems. Subterrestrial delimitation offers no easier solutions than those wrested from the sea or space.

There is a need for substantial continuing inquiry from scholars, scientists, and politicians. It is hoped that the present Article, if it has resolved nothing legally, scientifically, or politically, has at least awakened the great, slumbering legal issue of who owns Mother Earth.